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Admiral Pratt Supports Present Naval Ratio

American Naval Authority Contends Japan Does Not Need Parity

By Admiral WILLIAM V. PRATT

Admiral Pratt, now retired from active service, was one of the most distinguished officers in the American naval service. He was President of the Naval War College from 1925-27, Commander-in-chief of the United States fleet 1929-30, Adviser to the American delegation at the London Naval Conference in 1930, and Chief of Naval Operations 1930-33. His article in the July number of Foreign Affairs is reproduced below in full:

THE year 1935 will be a critical period in world affairs. For one thing, the importance of the naval conference which is to be held far outweighs that of ordinary naval discussions; the decisions then made will affect not only the participants, but will have world repercussions. The fact is that we have arrived at the forks of the road. One way leads uphill. It is new, tedious and long. It requires patience to negotiate. The old road is direct, broad and well-lighted, but it passes through dangerous country, as the grisly monuments by the wayside bear witness. A choice will have to be made. Bluntly speaking, will the props of the political world structure be forged out of the substance which is called confidence or out of cold steel?

In any consideration of the naval problems with which this country will have to deal in the near future we must turn back to the agreement signed at Washington in 1922 by the five chief naval Powers—the British Empire, France, Italy, Japan and the United States The Washington agreement remains in force until December 31, 1936, unless any party to it gives notice of intention to terminate it earlier; and, after notice is given, it takes two years before the agreement ends. Hence, unless notice is given by December 31, 1934, it will still be in effect up to the time when the London Treaty expires. Under the terms of the London Treaty, the five great naval Powers signatory to both the agreements are bound to meet in 1935, unless the earlier agreement had meanwhile been superseded by a general agreement limiting naval armament to which they all were parties. At this meeting the Washington naval treaty will still furnish both directive and background.

So much attention has been given to the naval agreement reached in Washington that one is apt to forget that it constitutes only a part of the work of that Conference, and in some ways is not its best or broadest achievement. The Four Power Treaty relating to island possessions and the Nine Power Treaty relating to principles and policies concerning China rank with the naval treaty. Taken together they form a series of connected documents which endeavor to set forth in legal terms the purposes for which the Washington Conference was called and the measure of agreement accomplished. It is to be noted that the preamble of the London Treaty starts with the words, "Desiring to prevent the dangers and reduce the burdens, inherent in competitive armaments, and desiring to carry forward the work begun by the Washington Naval Conference." This throws the London Treaty back on the Washington Conference for its broad general directive.

Purposes of Conference

The purposes of the Washington Conference were several. It endeavored first to smooth the path of peace. It hoped to be able to help stabilize conditions in China and the Orient. It strove to limit the dangers inherent in competitive armaments and to reduce the expenditures resulting therefrom. And it put forth a definite plan for naval limitation.

Thus it would seem as though some of the atmosphere of the Washington Conference must permeate the 1935 meeting. If it does, this should prevent the meeting from becoming a place for the discussion of problems viewed entirely from the technical standpoint. And speaking not as a technician, but trying to look at the problem in the broader way, one must conclude that it is wise to bring as much of the Washington atmosphere into the discussion as possible; for as we follow the course of the various arms proposals made from time to time, we see how many of them have been wrecked on some rather unimportant technical shoal.

A trifle more than thirteen years have passed since the Washington Conference met first, and in that time we should have been able to judge whether the results have on the whole been good or bad. Can anyone say that the results of the Conference did not for a while drive away the storm clouds in Asia? They appeared again in the shape of internal strife in China and in the Manchurian incident. But would not these same storm clouds have been more forbidding had the Washington Conference never taken place. Though some may not agree, the writer does believe that the general effect has been good and that in a measure the Washington Conference has been the logical successor of the two Peace Conferences which met at The Hague in 1899 and in 1907. And aside from the concrete accomplishments of the naval treaty, the generous spirit developed at the Conference provided the world with something which should not be lost to it now.

Of all the many conferences that have met in the last twelve years, how many produced any concrete results except those of Washington and London? None. The disarmament meetings at Geneva have been not much more than the motions of a debating society. The efforts there in 1927 resulted, let us say, in a technical victory for those who wished no limitations. It was the defeat of statecraft. Much depends upon the way one sees his problem. The purely military type of mind cannot view even reasonable limitations with anything save fear that his country's safety has been jeopardized. The statesman frequently feels that his case has been won if he comes to any agreement. There must be a happy mean between the two points of view. In 1932 President Hoover proposed to the disarmament meeting at Geneva a plan whereby a one-third reduction was to be made in naval and military forces. It took into account the inter-relationship between sea forces, land forces and air. This should have been done before. Twice now sea power has agreed to limit itself in the interests of world peace; or let us say impose regulations which each Power participating in the conference agrees to respect. But have there been any agreements on the part of the land forces to respect limits? No. For various reasons the answer is always the same. Security, national defense and other considerations demand that no reduction be made in land armaments by agreement, but the land Powers see no objection to further reductions being made in sea forces. Admitting the statement that voluntary reductions have

been made in the land forces, we must nevertheless note a concrete difference in principle and in essentials between voluntary reductions and limitation by agreement. One is under national control; the other under control through international agreement.

In the length of time it takes to build one batteship an army can be recruited, organized, mobilized, equipped, and a war fought. Nevertheless, the only force which thus far has made any concessions by agreement is the one which normally is under the greater handicap. Is it any wonder, then, that people regard land force as the more aggressive instrument of the two?

Let us grant the honesty of every motive and admit that we are not the only people that wish peace. It is nevertheless true that sea power is more liberal than military power, is willing to concede more in order to come to terms. But the time has arrived, as will be evident in 1935, when sea power will make no more concessions unless these are met by equal concessions on the part of land power. All countries which rely on sea power as their strong military arm must feel that without some concessions on the part of land power the entire question of limitation is rather hopeless.

Pleas for Security

Despite all logic, despite pleas for security, demand for national defense, or any other arguments, the movement to stabilize peace through limitation—the "minimum" process—will never get under way successfully until military and air power enter the discussion on the same basis as sea power and walk the same path. If they do not, it will mean ultimately a return to the old process—the "maximum" process—of balance of power. For when it comes to the crucial test of war, which no one, however peace-loving he may be, can afford to regard as outlawed in fact even if outlawed by treaty, then the ultimate decision will rest on the way the pendulum swings, whether it be toward sea power or toward military power. It has been so always. It was true in the Napoleonic Wars. It was true in the last war. It will be true in the next. And this understanding binds all sea Powers together, regardless of any disagreements they may have among themselves individually.

The MacDonald scheme, which is the basis for the British disarmament proposal brought forward a year ago, relegates naval limitation to the next naval conference, but insists that some sort of adjustment, regulation and restriction of military and air forces be made now. We are in accord in principle with this proposal.

A nation may be strong on land, or strong on the sea, choosing which arm she deems best suited for her safety. But beware that country which tries to be strong in all military arms, which demands equality or great power in each. The nation which demands these things may cry peace to the housetops, may insist that the needs of national defense will stand for no less; but watch her carefully, for such action is usually the foreunner of aggressive action or is induced by great fear.

In 1910, Germany had the most powerful army in Europe and was also building a great navy, the second in size in the world. In that year, when Herr von Bethmann-Hollweg was trying to secure an understanding with England, Sir Edward Grey had written to the British Ambassador in Berlin: "The mutual arrest or decrease of naval expenditure is the test of whether an understanding is worth anything." In 1913, when the First Lord of the Admiralty, Winston Churchill, proposed a twelve months' naval holiday to Germany, the latter refused. War broke in 1914.

Technical Consideration

Of the five great sea Powers which have met at the various naval conferences, only three, Great Britain, Japan and the United States, have thus far been sufficiently in accord to permit of their signing the full terms of both the Washington and London Treaties. It is interesting to note, in this connection, that these three are located so strategically that if they were all animated by the same ideals, administered by similar form of government, held the same liberal and tolerant views, and were adherents of the rule law, they could become remarkably useful instruments in maintaining world stability and peace. The keynote to the puzzle lies in the word "confidence." France and Italy have never been able to come to terms in all matters. The points where they fail to agree are more political than technical. The greatest divergence in technical views is found between Great Britain, Japan and the United States, yet we three are the only ones to reach complete accord thus far. This in itself goes to show that the real obstacles confronting limitation of armaments are political and not technical, a fact which present world tendencies seem to verify.

Great Britain and ourselves agree that the submarine should go. Japan wishes to keep the submarine on the ground that it is a defensive weapon. Great Britain's plea is that it will be used as it was in the last war and is therefore an inhuman weapon. We are willing to abolish it, if all others do, on the grounds that it is the least useful to us of all the various types of war craft and costs more per ton to build. There is no special logic in Japan's plea that the submarine is a weapon strictly of defense. It depends entirely upon how it is used; and used as it was by the Germans in the last war it becomes a most offensive weapon.

Here is a point worth noting. Much stress has been laid in recent disarmament discussions upon abolishing aggressive weapons. Aggressive acts can be outlawed, and perhaps on land it may be possible to define aggressive weapons, but on the sea there can be no line drawn between an offensive type of ship and a defensive type, in the classes in existence now. The Japanese have tried to prove that the battleship and aircraft carriers are offensive ships and that the submarine is defensive, but there is nothing to this argument technically. If it is desired to do away with or to limit a type as a matter of expediency, the proper method is to to abolish it, or to establish quotas or ratios by simple agreement. There is nothing new in this idea, but to attempt to defend a point of view by unsound argument is not good practice even in negotiations.

U.S., Britain Want Battleships

Great Britain and ourselves want battleships and Japan is not so keen about them now. They cost much money to build and a poor country cannot afford to indulge in them as well as a rich one can. From our point of view, considering offensive and defensive qualities, first cost of building, and maintenance, they are the cheapest investment we can put our money in and still obtain the best values. It might be interesting to note a few figures. The building costs per ton of warships in the United States are, approximately: battleships $1,050, aircraft carriers $1,280, cruisers $1,500, destroyers $2,500, submarines $3,000. Except in the case of battleships, our building charges are considerably higher than those of other nations. In the same class of ship, a vessel of small tonnage costs more per ton to build than a larger craft. The relative final efficiency merits of the various types can be figured to be about as follows: placing the battleship at 100, aircraft carriers and cruisers run between 50 and 60, destroyers between 30 and 40, submarines between 20 and 30. In the matter of tonnage and caliber of guns, in the battleship class, Great Britain wants smaller ships, with 12-inch guns but more of them. We want the larger ships with heavier guns, and the number we require is possibly less than the number Great Britain desire. The Japanese like the 14-inch gun, but whatever we have they want also. Probably in principle they would not object to a smaller battleship than is allowed under the terms of the Washington Treaty.

In the matter of aircraft carriers, Great Britain and Japan would probably be willing to reduce total tonnage allowances. We feel that the allowance established, viz, 135,000 tons, when the art of flying was more in the experimental stage than it is to-day, is quite small enough. It is already less than the total tonnage allowed for destroyers, which is 150,000 tons.

But the attitude of the different countries toward carrier tonnage depends upon their attitude toward aircraft. This attitude may be defined as regional, the regions being the continent of Europe, America, and the Orient. We are naturally one of the most liberal-minded nations about the air. We have nothing to fear. We do not care to place too many restrictions upon the air but for the sake of agreement are willing to make concessions, knowing that other countries have more at stake than we. We are willing to abolish bombing from the air, though it is more logical to restrict bombing to legitimate targets. The method of restriction is applied to other types of war craft; for example, the submarine may not do certain things, and other craft may not use their guns against unfortified towns. However, all countries are willing in general to do away with air bombing, though they do not all agree in the military uses of the air. Great Britain desires a very drastic cut in the numbers of military and naval aircraft allowed. Under the MacDonald proposal the maximum number allowed was 500.

Our total at that time was around 3,000 ; Japan, France, and Italy were fairly close to that figure ; while Great Britain was slightly less than 2,000. In the Orient, Japan is now the strong air Power. She does not object to the legitimate use of air force against others ; she does not care to have it used against herself in an unrestricted manner, a sentiment endorsed by the military men of most nations. If Russia gets to be a strong air Power in the Orient, Japan's final attitude ought to be the same as Great Britain's.

Building of Submarines

There are practically no technical disagreements in the destroyer class. However, since the destroyer is one of the best replies to the submarine, so long as any one country indulges in extensive building of submarines that fact will regulate the total destroyer tonnage considered reasonable. Especially is this the case now that so much pressure is being brought to abolish air bombing. Aircraft have been growing to be one of the most potent enemies of the submarine and if aircraft are limited more reliance will have to be placed on destroyers. France and Japan continue to regard the submarine with high favor.

In the matter of cruisers, we prefer the larger 10,000 ton ship, and in this class we favor those carrying 8-inch guns. Our allowance in this type of ship is greater than that of any other country, but Great Britain makes up for this by having a superior total tonnage allowance. She prefers the smaller ship carrying 6-inch guns, largely for the reason that she can get more of these on a total tonnage allowance than is the case if she has to build to her quota to equal Japan or ourselves in the 10,000 ton class. Our needs drop from the 10,000 ton ship straight to the 20,000 ton ship in the unrestricted class, of which all countries can build as many as they choose for peace-time purposes. We have no dependencies to defend and our need for cruisers is governed to a large extent by fleet needs. We therefore are inclined to favor a total tonnage allowance which is less than Great Britain thinks necessary. Japan's attitude here is much the same as our own.

In general, we might sum up the attitude of the three countries to be that Great Britain wants smaller ships and more of them ; we want larger ships and fewer of them ; Japan wants what we are allowed. The technical differences of opinion are many, but there is hardly one which ought not to lie within the range of amicable settlement. It is not in the technical sphere that the real obstacles lie.

Political Considerations

The Washington Conference met in 1921-22 in an atmosphere of internationalism and democracy. After the lapse of a short space of fourteen years, its child, the treaty limiting naval armament, will be examined afresh in an atmosphere of intense nationalism and at a time when democracy and the parliamentary principle are fighting to maintain themselves in the face of dictatorship expressed in various forms. We see rule by man, a principle of dictatorship, replacing the rule of law, one of the fundamentals of true democracy. We have only to read the newspapers to know that a large part of the continent of Europe regards democracy's day as over, though, as one leader stated, it may linger on "for a time in some odd corners of the earth."

Looking toward the Orient what do we see ? One country professing the democratic principle is torn with internal dissension. Another, intensely nationalistic and maintaining an autocratic form of government, is determined upon a course of action which will give it the place in the sun which it thinks its destiny requires. What is the meaning of the rapid changes of the last few years ? Broadly speaking the most expressive term is "dissatisfaction." It is not enmity ; but out of the seeds of dissatisfaction may spring a plant just as dangerous as the growth from the seeds of enmity. In either case, when the plant reaches maturity it is war. This dissatisfaction will be part of the background of the 1935 Conference unless conditions change materially in the meantime. In the face of this, and after the unsuccessful efforts at Geneva, where the League of Nations has failed to accomplish much in the way of disarmament, what nation will have the desire or temerity to put forth a proposal for further limitation of naval armament ? What sea Power—and mind you, the two greatest sea Powers are to-day among the chief guardians of the democratic principle—what sea Power then will wish to reduce its strength further in the face of a growing military spirit, especially when twice before the two sea Powers just mentioned made concessions and reductions in force, and on one pretext or another received no concessions in return ? What may we expect then ?

France and Italy have never come into full accord in the matter of limitation of naval armament. Italy insists upon the recognition of the principle of equality in naval strength, though she is willing to agree not to build up to the standard set by France. France has not been willing to grant equality for the sake of arriving at agreement. She claims that her greater defensive necessities, in part connected with the defense of her North African realm, give her the right to a measure of greater sea power, a right she does not care to relinquish. France, which we must admit to be a nation of logical thinkers whether or not we agree with them always, has maintained steadily one principle : she will not disarm unless she can be assured of security, and she bases her appraisal of what constitutes security upon past experience.

England has expressed dissatisfaction at being bound by terms which place her at a disadvantage with regard to others which will come to no terms. Although she is one of the foremost exponents of the limitation of armaments idea, she has stated that she no longer intends to carry on in the way of limitation by example ; she says that it is a mistake.

Outlook for Disarmament

What is our stake ? Since we are not closely surrounded by real or imagined dangers, we look upon disarmament with a broad, generous outlook. We think it a good thing for the general cause of peace, and we think it ought to be pursued. Besides, it has the advantage at the moment of being economical. We have made one serious error, however ; and that is, having made arms agreements in the past, we have not lived up to them. We thought it a fine gesture for peace, as well as inexpensive, not to build up to our quotas quietly and systematically. Then when we find we are wrong we are forced to repair the damage—whether the times be propitious or not for such efforts.

Our stake is to prevent war, for looking at the matter even in the light of self-interest only, we see that we are bound eventually to pay a large part of the price of any great war, regardless of any immediate profits which might accrue to some classes of our citizens as a result of our being neutral. All nations through their spokesmen are proclaiming peace ; they probably want it. At the same time they are all bent on being strong ; they all intend to get their own way. Is the cause of world peace served better by our being weak or by our being firm and strong ? This is one of the things we shall have to ask ourselves at the next Conference, and we may as well be honest and face it. The atmosphere is not what it was in 1922.

What does Japan want ? Let us admit at once the two objectives—equality and security—stated by Viscount Ishii as the permanent bases of Japanese foreign policy. Although almost universally censured in the Manchurian episode, an old sore, Japan had some rights on her side. From the technical and military viewpoint, Japan had a weak link in her armor unless she had a foothold in Manchuria. Every time she had gained this foothold by war she had been made to give it up by outside pressure. Under these circumstances, other nations might have felt just as she did —previous to signing the Nine Power Pact and the Paris Peace Pact. They might not have acted in the same way after having signed those agreements. They would have tried to find other ways to get their requirements satisfied.

It has been stated openly in the press that Japan at the next naval conference will ask for an increase in the naval ratio assigned her. Is the request logical on the ground of security ? It is not, and technical men know it. Listen to the words of Admiral Baron Kato spoken at the second plenary session of the Washington Conference in reply to the American proposal setting forth the 5-5-3 ratio for the first time. Speaking of Japan, Admiral Kato said in part : "She is satisfied that the proposed plan will materially relieve the nations of wasteful expenditures, and cannot fail to make for the peace of the world." And again : "Japan has never claimed nor had any intention of claiming to have a naval establishment equal in strength to that of either the United States or the British Empire. Her existing plan will show conclusively that she had never in view preparation for offensive war." In addition to the ratios established at Washington, the three sea Powers at the London Conference agreed to equality in submarine tonnage. This action more than

made secure the Japanese islands themselves as well as the road from the islands to the mainland, even though the total tonnage allowance for each nation was cut to approximately 53,000 tons.

Let us ask ourselves certain questions.

Japan's Role As Neutral

In time of war, does Japan have the seas of the world to cover as a necessary part of her own security, as does the British Empire? She does not, and in addition she has a secure line to the mainland which England has not.

Does Japan have two great ocean fronts and one of the main water arteries of the world to defend in case of war, as does the United States? She does not.

As a neutral in a great war, would the obligations and responsibilities imposed upon Japan put as heavy a burden on her shoulders as they would upon either Great Britain or the United States? They would not.

Is there any nation in the world, which, after taking care of its essential obligations at home and elsewhere, could lay successful blockade to the coast of Japan? There is not.

In the last half century has there ever been any action taken against Japan on the part of the two leading sea Powers which legitimately could be called aggressive? The writer thinks not.

Is a Japanese claim for increase of ratios justified on the grounds of national income? Japan's national income is approximately 16½ times less than ours, yet in the eleven years following 1922 her expenditures for new naval construction exceeded our own during eight of those years, and the ratio of her naval budget to national income is 5½ times greater than our own.

No, the Japanese claim for an actual increase in her naval ratio will not further the purposes of peace, and must find other reasons than equality and security.

However, though Japan has no logical grounds to lay claim to an increase in her naval ratio she has a just claim to equality in treatment in other respects, and until that claim is recognized there will remain a feeling of tension. International relations must be based on a spirit of fair play, equality and justice, if peace is to be kept. Is there sany reason why friendly relations should not be maintained between this country and Japan? No. So long as each country respects the other's rights, lives up to its treaty agreements, enters into no trade wars, develops no superiority complex, starts no war propaganda, attends strictly to its own business, is just in its dealings with the other, and truly desires peace—so long there should be no apprehension. The Pacific has not been the breeder of war hurricanes that the Atlantic and Mediterranean have been. Thus far calms or only fresh breezes have prevailed.

No one can predict what the outcome of the forthcoming naval discussions will be. The best that can be hoped is that the nations will meet in such an atmosphere of friendliness that the good resulting from the previous conferences may not be lost and may be carried on and increased. If the disarmament efforts of the League of Nations come to naught the world will badly need some relic of the spirit of the Washington Conference.

Meanwhile, there are certain things which seem self-evident. If we and the other nations of the world are actually on the road out of a depression resulting largely from the last war, and if many tariff and financial questions are in process of fair adjustment, this fact will do much to soften the present rather harsh political atmosphere and bring to the next Conference a spirit of greater optimism. If the writer can surmize correctly, it will be a meeting where men and their attitude towards each other will count for more than any logical presentation of facts. No nation would care to be responsible for setting the clock back, for calling into existence again the old system of naval competition, with its attendant evils and balances of power.

But if the ship sinks, the readjustment period should find those with identic interests in the same lifeboat.

Soviet Air Force Menaces Japan

By Rear Admiral YATES STIRLING, Jr., U.S. Navy in the "New York Herald Tribune"

THE Japanese representatives at the Washington conference on limitation of armaments in 1921 were so much concerned over the possible expansion of the British naval base at Hongkong and the United States naval base at Manila that before agreeing to the 5-5-3 ratios at that conference, they caused to be written into the treaty the virtual abandonment of those fortified naval positions. Japanese naval policy at that time saw clearly that superior fleets of those nations, securely based in the Orient, would exercise a strong veto power to prevent the carrying out of Japanese political intentions toward China which might not harmonize with the political interest of those sea powers.

Great Britain, while agreeing to retire from Hongkong, insisted upon a new naval position for her fleet at Singapore. An effective British fleet based there will be in the focus of Oriental trade routes and will be a distinct discouragement to any hostile attempt by Japan upon India, the Dutch East Indies, Borneo, Australia and New Zealand. It seems assured now, as ever, that the British policy is unwilling, even with a fleet much smaller in number than formerly, to give up Britain's boasted control of the seas in all parts of the world.

Great Britain visions that her control of the seven seas lies primarily in her cruiser strength. With cruisers in numbers and with correctly located bases for them along essential trade routes, British trade can be given adequate security. When we consider that $800,000,000 worth of British property, ships and cargoes are afloat daily in the China seas, Australian and Indian waters, it is only natural that Great Britain will desire to maintain the safety of this essential wealth.

The United States, abandoning the Manila base, was obliged to be content with her nearest naval base in the Hawaiian Islands, 4,000 miles from Oriental waters. Our loss in giving up a naval base in Philippine waters was in decreased mobility of our naval ships in the Orient and in a decline of national prestige in the Far East. Our floating trade out there is negligible compared with that of the British Empire. At Hawaii the United States fleet menaces Japan far less than Great Britain's fleet does at Singapore.

Limitations Reduce Warships

Limitation of naval armaments has considerably reduced the number of warships in each class available to each of the great sea powers. This shortage makes it increasingly difficult for Great Britain, while retaining naval power in other areas, to send an adequate fleet to base at Singapore for the protection of its Empire committments. In a war between Great Britain and Japan the British navy would wish to have nearly the entire existing fleet in Oriental waters. Victory might not be bought with less. Limitation of armaments works a hardship to sea powers like Great-Britain, and in a lesser degree to the United States, due to the far flung obligations of those empires, by decreasing the number of warships available to each. Insufficient numbers of warships can be held outside of a possible Oriental war zone to retain naval power elsewhere.

Japan profits in comparison, because her empire is more compact and requires fewer ships for defense while none are required to be held outside the war zone. This geographical consolidation of the Japanese empire also makes it inevitable that any war in which that nation may be engaged will be fought almost certainly near her home bases.

Until only a short time ago, Japan believed her security lay in building up her fleet to treaty ratios and excluding rival sea powers from naval bases close enough to threaten her lines of

communication and her industrial centers. Japan's attention has been directed more especially toward Great Britain and the United States, with war fleets numerically superior to her own.

A naval base has been likened to a gun, and a fleet to the projectile fired from the gun. The fleet finds at the base a secure anchorage, supplies, repairs, fuel and recreation for the personnel. The fleet when "fired" by the base can operate only a certain distance in time and space, then it must return for fuel and supplies and, if it has been in contact with enemy ships, for repairs to injuries suffered in action. The distance a fleet can operate from its base depends upon the steaming radius of the individual ships and upon the speeds used by the several ships of the fleet. Twenty-five hundred miles seems a conservative estimate of the distance a fleet may go under normal conditions. The base as a gun firing a fleet may be said to have an effective range of about 2,500 miles. Individual ships may be capable of going much farther.

Singapore is 2,900 miles, while Hawaii is 4,400 miles from Japan, both are, therefore, outside the "base range."

Importance of Bases

In the past it has been difficult to make our countrymen realize the great importance of outlying bases to a fleet. Home bases receive support and are supplied almost too plentifully. The home bases furnish mobility to warships, but only to a definite distance from our shores. As a gun, the home base "fires" the fleet in any direction to seaward. If the arc of the circle representing half the fleet's steaming radius does not include an outlying base, the fleet must return after it has reached the arc of the circle. If there is a base, in the direction of the fleet's advance, within the arc, where supplies, fuel, refit and security can be obtained, then the outlying base becomes a new gun and can project the fleet further on its mission. In not supplying outlying bases for our fleet, we might be said to have furnished a projectile, the fleet, without the essential gun to "fire" it.

A British fleet at Singapore or a United States fleet at Hawaii must, therefore, be considered on the defensive and not in anyway a menace to Japan, for both bases are outside the "base range" of Japan.

In addition to her naval bases in the home territory, Japan has outlying naval bases in the islands of Amami, Okinawa, Bonins and Pescadares. These bases flank the advance northward of a hostile fleet from Singapore. Potential bases in the Japanese mandated islands, the Marshall, Caroline and Ladrone, similarly threaten the advance of a hostile fleet from the Hawaiian Islands.

While Japan was making herself secure from possible aggression by the great sea powers, she seemed to have overlooked the potential semi-naval threat of China and Russia. True, these nations are lacking in sea power, yet the Russian port of Vladivostok is scarcely 600 miles from the center of Japan's industrial activities and the mouth of the Yangtze River is at about the same distance.

Having accomplished her aim of materially reducing in Oriental waters the effective sea power of Great Britain and the United States by enforced abandonment of naval bases at Hongkong and Manila, it seems evident that the Japanese national leaders are becoming increasingly concerned over the potential menace of Russia and China. The "Sword of Damocles" seems now to them more real than they had imagined. Is it not logical to suppose that the pronouncement on April 17, 1934, that Japan looks with disfavor upon the training of Chinese aviators by foreigners and the supplying of airplanes to the Nanking government by foreigners is Japan's way of informing the nations that an air-minded China is not to the interest of the Japanese Empire?

If we glance at a map of the Orient, we shall see the islands of the Japanese empire, stretching along the coast of Asia, enveloping the eastern Siberian and much of the Chinese coast line, at distances ranging from 450 to 600 miles, well within the effective range of bombing airplanes. This separation of Japan from the mainland of Asia was at one time considered a safe enough distance for a nation like Japan with sea power sufficient to hold command of all the seas in the Orient.

Is it not likely that Japan now has awakened from her pleasant dream of security and is shocked at the realization of her vulnerability from China and eastern Siberia? The air exploits of the leading nations of the world in the last few years are none too reassuring to her and doubtless make the Japanese leaders none too happy when they realize that scarcely 600 miles (four to five hours' flight of a modern bombing plane) separate their industrial centers and their great naval bases from Russian air forces said to be concentrated in the vicinity of Vladivostok. The creation of a formidable Chinese air force with foreign-trained aviators and foreign-made airplanes naturally must add its weight to Japan's uneasiness.

Occupation Reduce Menace

Full security of the Japanese islands from air raids from the mainland of Asia can be achieved only through the military occupation by Japan of all territory that holds a menace. That would mean not only Manchukuo, already under Japanese control but all of Russian Siberia to Lake Baikal and nearly all of the eastern provinces of China.

The menace of the sea power of Great Britain and the United States now pales to insignificance before this practically new threat.

An air attack from either of the two sea powers must be accomplished by the use of airplane carriers. This is serious enough, but warships are vulnerable and the Japanese navy can be alert to defeat such a venture. On the other hand, there is no effective reply to the Russian air threat, except the destruction of the potentially hostile air power while yet on the ground.

The proximity of a large number of Russian war airplanes ready to atack Japan, therefore, must be accompanied by eternal vigilance on the part of the Japanese. This ever present and continuing menace must in the end, through increasing nervous tension, cause a breakdown of morale and hasten the action of the war ferment now brewing. Russia and Japan, if history can be considered a guide, must both agree to maintain a neutral zone between them, from which zone war airplanes will be excluded by both powers. This neutral zone must be wide enough to remove the present tension and give Japan a feeling of certain security from surprise air attack on her industrial centers and her highly inflammable cities. The situation at present seems too taut and filled with dire possibilities to be continued indefinitely.

Japan, having bought her present security through large expenditures of money and blood, will not be willing to live with a "Sword of Damocles," the Russian air forces near Vladivostok, continually hanging over her head, and one seems justified in believing that when the situation becomes more than that sensitive nation can bear, she will strike to remove this menace, fancied or real.

This air situation, not the menace of the sea power of Great Britain, not that of the United States is the present concern of the military and naval leaders of Japan. Diplomacy or war in the Orient must decide in the near future the method of bringing about stability in one of the sorest spots on the world's surface.

China Highway System

It is reported in American circles that Col. Frederick Stuart Greene, Commissioner of Public Works for the State of New York, has been asked by the Government of China to supervize the construction of an elaborate system of highways. The report is to the effect that the Nanking Government desires the construction of 22,000 miles of modern durable roads, and that Col. Greene had been asked to help in producing the plans as well as to oversee the work.

Construction of highways in Hunan, Hupeh, Fukien, Chekiang and Kwangtung has been on a large scale. In places where transportation formerly took three days, it now takes only half a day or six hours by bus. Long distance telephones along all the trunk lines are being installed. Short wave radio stations have been established at Chian, Fuchow, Pinghsiang, Kanchow, Nancheng, etc. Small aerodromes have also been constructed in these places. Mr. Chao Chu-kan, chief of the highway section of the Economic Commission, states that the Commission are planning the construction of 22,000 kilometers of highways. They have completed 1,043 kilometers in Anhui, Chekiang and Kiangsu, 2,600 kilometers connecting the seven provinces of Kiangsu, Chekiang, Anhui, Kiangsi, Hunan, Hupeh and Shantung, and construction will soon begin on 2,800 kilometers of highway.

Matsuoka Defines Japanese Aims*

By YOSUKE MATSUOKA

THE next naval conference must succeed. We cannot afford to let it fail. For if the conference ends in rupture, it would spell a disaster for the world. If we wish to insure its success, it is high time for us to set about improving the feelings and sentiments in both Japan and America towards each other. This is a most urgent necessity, being the first and fundamental condition of success. Viewed economically, friendship, not enmity, is destined to develop between our two countries, as our trade relations are complementary rather than competitive. On the one hand, Japan is your best customer in the whole Orient. She is, in truth, the third largest customer for American goods, surpassed only by Great Britain and Canada. On the other, America takes roughly 30 per cent of the total Japanese exports. Japan has never encroached upon your legitimate economic interests in the past. She will never do so in the future. Viewed materially, therefore, there is no substantial cause of conflict between us. Modern war is a war of attrition in which victor and vanquished alike suffer severe losses. Moreover, war between America and Japan would be a crime against civilization. Mere absence, however, of apparent causes of conflict does not constitute in itself a sufficient guarantee for peace.

Misunderstandings Exist

I am afraid there are misunderstandings on both sides of the Pacific. Let me speak frankly. On our side, Japan is irritated over America's insistence on playing the big boy's part in the East. At least, so it appears to us. We refuse to be bullied and resent any attempt at it. We have consistently respected your rights and interests in your sphere of influence and never once challenged the Monroe Doctrine. I want to ask you to respect Japan's Monroe Doctrine of the East. When I say Monroe Doctrine, I refer to that Doctrine as expounded by Mr. Hughes and Mr. Kellogg, two of your former Secretaries of State who gave us to understand that the Monroe Doctrine, in the final analysis, rests upon the right of self-defence. Should America recognize and respect Japan's Monroe Doctrine of the East, many misgivings on our part will disappear. And what would America lose thereby ? Nothing! Not only that but you will gain our appreciation and friendship. On the American side, some of you are scared by the nightmare of a sudden attack from us. Nothing could be more absurd. I need hardly assure you that no sane person in Japan entertains such a wild dream. What can Japan possibly expect to gain from such a hare-brained adventure ?

I trust America's aim is peace on the Pacific. But your thesis of peace forbids Japan even a sporting chance in fighting America. You propose to police the vast Pacific Ocean by yourselves. At least that is our impression. However, no powerful and self-respecting nation would ever consent to be bound foot and hand by others. Just reverse the case. Would America allow herself to be so bound by Japan ? I know the answer would be a definite "no." America tries to impose upon us an inferior ratio and Japan resists it. Herein lurks a danger to peace. To avert this danger, America must revize her policy and must more clearly show an attitude of co-operation with Japan and Great Britain for the maintenance of tranquility in the Pacific. Why must you act in such a way as to impress upon others that you alone are to be trusted in the police duty of the Pacific. Can't you trust others? Suspicion is not a worthy quality of a great nation. What fun would America miss by sharing the task of maintaining peace on the Pacific with Japan and Great Britain on equal footing ?

Japanese Contention

With your vastly superior wealth, you can build as many warships as you want and out-build others in the armament race, while Japan can ill afford to do so. Therefore, it is up to America, rather than to Japan, to decide whether there should be increase or decrease in armament. If America truly looks for peace, she should stop building. Then, Japan will also stop. If, however, America continues to build, thereby incidentally betraying a suspicious mentality towards us, we will also build to the last cent in our purse, although we hate to do so.

The Japanese contention for parity, as a matter of principle, with America and Great Britain should not alarm you at all. Have we not a right to claim it ? Reverse the case again, and what would you say ? Let us admit plainly a natural right such as this—so patent that there is no room to dispute it—and then let us get down to the facts of the case and reach a sensible modus vivendi. That, to my mind, is the only way to do business. Let us be practical.

China is altogether too gigantic a country for Japan alone to help restore peace and order there. Japan, moreover, has her hands full for many years to come in assisting Manchukuo to grow into a healthy independent state. Much as I regret it, I am obliged to say that, left alone, China will continue to sink deeper and deeper into the mire of chaos and confusion. This hopeless condition constitutes a serious menace to Jaan, as we, more than anybody else, are exposed to the dangers arising out of such a condition. We therefore, are most anxious to see China saved from the present misery and misgovernment. If America and other Powers interested in China desire to extend cooperation to that end, we shall gladly respond to it. My advice is that America should make clear to the warlords and politicians of China the futility of their game to alienate and antagonize Japan and America. So long as China indulges in the foolish dream of keeping our two countries at loggerheads, so long there will be no real hope for peace and order in that country. Sentimentalism accomplishes nothing. It only leads to trouble. We must face the realities of the situation, if we mean to accomplish anything. Suppose for a moment that Japan did not exist or that Japan was a powerless nation. Then, there would have been no China to-day. You must admit, whether you like it or not, the fact that Japan has very largely contributed to the preservation of China and to the stability of the Far East. To-day, Japan is the sole hope of peace, order and progress in Asia. If you look for disorder, chaos and retrogression, then combat Japan. If not, support her. I beseech Americans to think clearly on this issue.

Japan and Russia

There are some questions to be settled between Japan and the U. S. S. R. These are questions, I feel sure, amenable to peaceful solution by diplomatic negotiations. On the issue, however, of the subversive activities of the Soviet Government in organizing a universal revolution of the proletariat and sovietizing China, Japan can permit of no compromise. Recently, some of the Russians seem to be scheming to utilize America as a counter-weight to Japan, taking advantage of your recent recognition of the Soviet Government, but I believe your people have too much commonsense to be made a cat's paw. Should, however, America allow herself by any chance to be so involved as to create an unfortunate appearance of aligning herself with Russia against Japan, it will only aggravate the situation in the Far East and prejudice the peaceful settlement of questions between Japan and the U.S.S.R. It will certainly not contribute to peace in this part of the world or elsewhere.

Trade is the vital issue that lies at the bottom of international relations. We hear nowadays frequent charges against the expansion of our export trade. This is absurd as well as ridiculous. Statistics patently establish the fact that Japan is a buyer in world markets. Japan's excess of imports over exports for the past sixty-four years (since 1868, the first year of Meiji) amounts to some 4,500,000,000 yen. Even last year, the peak year of our export since the world depression started, we imported more than we exported to the extent of approximately 85,000,000 yen. Our people are obliged to earn their living by exporting their wares to foreign countries. I would hate to think the world were so insensible as to deny to our industrious people their modest subsistence. And

* *As Published in Scripps Howard Newspapers in the U.S.*

hy this insensate fear of the dumping of Japanese goods? Will hey increase boundlessly and over-run the world market? Non-ense! We trade not for joy of it, but in order to live. Naturally t will, in the end, be limited by the necessities and conditions of the ivelihood of our people. Moreover, the output of our labor will be estricted by the natural conditions and amenities obtaining in Japan which are part of our inheritance. By supplying the world with comparatively cheap goods of good quality, we are really erving the true interest of humanity. Why compete with, or even shut out, these goods which you can only make at higher cost and a great disadvantage? Why not buy them, thereby enabling you to spend less in procuring the same thing, and devote yourself to turning out other goods that you can produce better than we can and sell them to us? Doesn't this sound commonsense?

System of Trade

You cannot trade on the "buy my goods but I won't buy yours" system. If you bar the importation of the goods of others, they will retaliate in kind. If you insist on this system, you will kill international trade. It is suicidal for you too. If there is one thing likely to be more effective than any other in correcting the present abnormal diminution of world trade, it is free trade. But if you have no courage to accept it outright, at least let us take heart to lower tariff barriers—the greatest obstacle to the recuperation of world trade.

I hold that the restoration of the economic prosperity of the world is made possible only with recovery in the volume of world trade as a whole. It has dwindled to one third of that of 1929. Herein lies the main ailment. It is self-evident that the recovery will be set back to the extent to which the world refuses to purchase our goods plus the extent of the decline in the buying power of our nation, which such refusal will occasion. I repeat, Japan is still a buying nation. Why try to put the buyers out of business, and further decrease the volume of world trade? Do you discern any hope for economic recovery in such tactics? We all must be doing everything in our power to increase the total volume of world trade, or else we can never hope really to get on our feet again. By doing anything that tends to stifle international trade or decrease its volume, certainly you will get nowhere. In this sorry world of ours, we must all hang together or, as Benjamin Franklin said long ago, we shall all hang separately.

The Open Door in Manchuria

By HENRY W. KINNEY

So many charges to the effect that the "Open Door" in Manchuria has been closed, have been made by uninformed politicians and writers abroad, who quite evidently have not even taken the trouble to study trade figures, that it seems worth while to make a study of the totals of Manchoukuo trade. The results will show that the countries, the nationals of which have been complaining the most, are the very ones which enjoy the most favorable trade balance. *The United States*, from which come usually the most bitter comments on the trade situation, *enjoys a trade balance far more favorable than that attained by Japan.*

The totals of Manchoukuo's foreign trade for the first four months of 1934, recently issued by the Finance Department of the Manchoukuo Government, are as follows:

	Exports	*Imports*	*Total*
Japan	68,146,913	96,123,213	164,270,126
Korea	12,712,052	8,141,668	20,853,720
China	17,048,205	25,135,964	42,184,169
Russia	8,736,523	3,012,497	11,749,020
Hongkong	2,332,608	2,908,088	5,240,696
British India	185,132	5,906,372	6,091,504
Netherlands India	2,110,319	230,654	2,340,973
Great Britain	1,940,482	2,093,491	4,033,973
France	724,517	206,512	931,029
Germany	27,617,682	2,931,429	30,549,111
Belgium	92,003	351,097	443,100
Netherlands	1,588,298	47,949	1,636,247
Italy	694,887	246,108	940,995
U.S. of America	2,061,876	11,189,117	13,250,993
Other Countries	20,196,810	6,860,477	27,057,287

It will be seen from the above figures that when one considers the common maxim that the countries which sell should also buy, the Anglo-Saxon countries have been especially fortunate in the case of Manchoukuo, as they have sold far more to that country than they have bought.

The case of the United States is a particularly striking one, as that country has sold five times as much as it has bought, being in this respect by far the most favored country, even when compared with *Japan*, which *has a favorable trade balance with Manchoukuo of only 1½ to 1 as against that for the United States of 5 to 1.*

Even when a comparison be made of the condition of American trade in Manchuria under the Chang regime with the present condition, there seems to be no just cause for complaint. One may thus compare the figures for the entire year of 1929, when world trade was good, with those of the first four months of this year, as follows:

	Imports to Manchuria	*Exports from Manchuria*	*Total*
1929 (Entire year, Haikwan taels)	25,890,078	10,258,179	36,148,257
1934 (First four months, yuan)	11,189,117	2,061,876	13,250,993

It must be remembered that the Haikwan tael is a somewhat larger unit than the Manchoukuo yuan (roughly 1 Yuan=Tael 0.70), but it does not effect the proportionate showing of exports and imports. It will be seen that the total of American business with Manchuria has not changed materially, but what is the most striking is that *the balance of American trade with Manchuria, which was in the ratio of 2½ to 1 in favor of America in 1929 has now mounted to the ratio of 5 to 1 in favor of America.*

It seems doubtful if there can be many countries where the United States enjoys so favorable a trade balance as she does in the case of Manchoukuo. Certainly the Manchoukuo trade balance is conspicuously good when considered in comparison with the total trade of the United States for Asia, which (according to a United Press dispatch, dated Washington, July 12) shows a balance unfavorable to the United States of U.S. $80,000,000. The customs figures for China for last year give United States exports to China at Mex. $297,468,131 and her imports from China at Mex. $113,-146,444. In other words, *America's favorable trade balance with China stands at a ratio of less than 3 to 1, while that with Manchoukuo stands at a ratio of 5 to 1.*

The United States favorable trade ratio with China is, as a matter of fact, better than that of Japan with Manchoukuo, the former being 3 to 1 and the latter about 1½ to 1. In this connection it must also be considered that the Japanese population in Manchuria, which consumes Japanese goods, such as food-stuffs, clothing, etc., is infinitely greater than is the foreign population in China, which consumes foreign goods. (British, American, French and German nationals in Manchuria total less than 1,200, while the Japanese number over 300,000). That Japanese builders and contractors, who are constructing most of the public works in Manchuria, and who, incidentally, are furnishing the bulk of the money therefor, should use mainly Japanese materials, may hardly be considered an unique phenomenon, especially in these days when various countries are busily constructing barriers against Japanese in ports. Furthermore, it is usual for foreign nationals undertaking such work in China to show a similar preference for

materials from their own respective countries. Still, in 1932, the direct purchases of American goods of the South Manchuria Railway Co., an entirely Japanese concern, in which the Japanese Government owns a half share, were Y.2,155,219, or 3.9 per cent of its total purchases from all sources, while in 1933 its direct purchases from the United States were Y.5,639,316 or 4.7 per cent of its total purchases from all sources. It must be added that the above figures apply to direct purchases only, and do not take into account the purchases made indirectly, as, for instance, from importers of American goods in Japan. It is impossible to obtain figures in this matter, but the goods involved must amount to a fairly considerable total.

When one considers the case of British trade, one finds that each of the British territories named enjoys a favorable trade balance in respect to Manchoukuo. *The totals for Great Britain, Hongkong and* British India show Yuan 4,458,222 for goods bought from Manchoukuo and Yuan 10,907,951 for goods sold there, or *a ratio of more than 2 to 1 in favor of the British.*

It must also be remembered that quite a large volume of goods listed under the total for Japan are, as a matter of fact, foreign goods, especially American, which have been trans-shipped from Japan or which have been sold by Japanese firms, while in some cases parts have been imported from abroad and have been assembled or incorporated into articles which have then been sold by Japan in Manchuria, thus appearing in the customs figures quoted as Japanese goods. It is manifestly impossible to ascertain exact figures in this connection, but it is admitted, even by foreign officials, to be large.

It may seem rather curious that countries which have quite large unfavorable trade balances in respect to Manchoukuo, such as, for instance, France and Germany, are making far less complaint, if any, than are those which enjoy a favorable position, Germany, which has an unfavorable trade balance against her to the extent of 1 to 9, is making serious efforts to overcome this by sending special government representatives to Manchuria for the purpose of studying means for establishing a fairer balance of exports and imports, while France, whose unfavorable ratio stands at about 2 to 7, has also sent a number of representatives of large industrial concerns, whose method it is to obtain public works and similar contracts on a long term credit basis.

Steel Making Processes with Particular Reference to the Production of Steel Castings

By P. B. PARKS, Steel Metallurgist, The Hongkong & Whampoa Dock Co., Ltd., Hongkong, Member of the Iron and Steel Institute. The Sheffield Metallurgical Association. The American Society for Steel Treating

SOONER or later most successful Iron Works and Foundries are compelled to consider the question of making steel. This situation arises because the larger and more important tenders will often contain an item or two in Cast Steel; also because in any industrial centre absorbing Iron Castings, certain customers will eventually want something better, thus slowly creating a demand for steel. These progressive customers must perforce address their enquiries to the local Iron Foundries and thus it is that initial experimental attempts at steel making are almost invariably sponsored by these concerns. This Paper, therefore, is an attempt to outline the elementary principles involved in steel making, with the object of assisting the progressive steel maker in dealing with some of the major difficulties which he may confidently expect. That the fundamental differences between Iron and Steel are too seldom realised or appreciated is one of the facts the writer wishes to emphasize, and the following details are put forward with the object of throwing more light on this matter in the hope that costly mistakes may be averted in the absence of technical advice or experience.

Fundamental Differences Between Iron and Steel

It is very unfortunate for the laymen that the word "Iron" is capable of several different interpretations. Strictly speaking, Iron is a chemical element, (Fe), and as such is very rarely found in nature; it is, in fact, a metallurgical curiosity; but Iron of 99.9 per cent purity can be produced electrolytically. The term "Iron" however, is more often used to infer either the product of the Blast Furnace, which actually is Pig-iron or the product of the Cupola Furnace, which is Cast Iron. Both these materials are very complex compounds of which, approximately, only 90 per cent is actually Iron (Fe), the remainder consisting of varying amounts of the elements Carbon, Silicon, Sulphur, Phosphorus and Manganese.

Other confusing variations are Malleable Iron and Wrought Iron, the former really being decarbonized Cast Iron, whilst the latter is the result of a crude process in which most of the impurities are oxidized out of Pig-iron, without, however, getting it at any stage to a really molten condition. These definitions are purposely very brief, as it is the writer's intention to compare only the Ironfounders' standard product, *i.e.*, Cast Iron, with ordinary commercial Cast Steel.

Cast Iron from the Cupola Furnace, whether it be produced by re-melting Pig Iron or miscellaneous Cast Iron scrap, is really, when viewed from the steelmakers' point of view, a very crude and impure material. Normally it contains as impurities large amounts of Carbon (two to four per cent), Silicon (one to three per cent), Phosphorus (0.25 to 1.25 per cent) and Sulphur (up to 0.15 per cent), and it is the unavoidable presence of these impurities which render it unworkable and limit its tensile strength to 12 to 14 tons per sq. inch. On account of its ready machinability, it fulfils a great many engineering purposes, but its popularity is in no little measure due to its easy manufacture and consequent cheapness. The comparatively low melting and pouring temperatures (around 1,200°C) of Cast Iron require the use of only the cheaper refractories, such as common firebricks and fire-clay, whilst its high Carbon and Phosphorus contents keep it molten and very fluid for a considerable period, thus making for easy and comparatively leisurely pouring conditions. When these characteristics are compared with those pertaining to Cast Steel the intelligent Iron-founder will quickly realise how vastly different the two materials are, and how long experience in the manipulation of Cast Iron can even be a handicap in the making of Cast Steel.

Steel is a material in which, broadly speaking, only Sulphur and Phosphorus are regarded as impurities, and consequently the maximum permissible amounts of these undesirable elements are generally stated in the specifications. In special cases the limit is as low as 0.030 per cent, but in ordinary steels it is usually 0.050 per cent. The other elements, Carbon, Silicon and Manganese, are present in small but definite quantities according to the specification of the particular steel required. Steel primarily intended for the manufacture of castings is commonly designated Cast Steel, but again this is an unfortunate term, since all steel, including Forged and Rolled Steel, is originally Cast Steel. (If the steel is subsequently intended for forging or rolling it is cast into metal moulds, the ingots thus produced being really crude steel castings). The majority of steel castings produced by the non-specializing foundry will fall under three categories which are determined by their Carbon contents. These groups are arbitrary, but usually range as follows: Soft steel containing 0.15 per cent C. maximum; Mild, 0.15-0.25 per cent C; and Medium, 0.25-0.45 per cent C. In all these qualities the Silicon should range between 0.15-0.35 per cent, the Manganese 0.60 to 0.80 per cent, while neither the Sulphur or Phosphorus should exceed 0.050 per cent. In order to obtain the mechanical tests required by public authorities, such as Lloyd's, the Board of Trade, and the majority of railway companies, these specifications must be strictly adhered to, so that it will be appreciated that compared to Cast Iron, Cast Steel is

a very pure and high-class material needing considerable technical skill for its successful production. Added to this, the proper pouring temperature of molten steel is around 1,600°C, some 400°C higher than that of Cast Iron, from which it will at once be apparent that special bricks and refractories must be used for the furnace and ladle linings. This also applies to the sands and facing materials required for the moulds, which fact incidentally, is one of the most frequent sources of trouble where steel is being made in an iron foundry. From the author's experience, another very difficult problem is to get the ironfounder to realise the short solidifying or "freezing" range of molten steel. As before mentioned, molten Cast Iron, owing to its very high Carbon and Phosphorus contents, will remain fluid for a considerable period. The ironfounder can tap his cupola into a ladle and then wait ten to fifteen minutes and tap again until the ladle is full, after which the metal will still be sufficiently fluid to fill the moulds quite easily. In the case of Cast Steel, particularly if it is of Soft or Mild quality and if small "shank" ladles are being used, the metal commences to thicken immediately, and unless it is poured expeditiously, it will, within the space of a few minutes, be too sluggish to properly "run" the castings. Even if it apparently fills the moulds, unless the metal in the head is hot enough, the normal contraction cavity or "pipe" will be imprisoned in the casting itself instead of being located in the head, for which special purpose the latter is, of course, provided. Again, owing to the very high temperatures involved, everything with which the molten steel comes into contact must be bone dry,—the ladles and moulds particularly,—otherwise steam will be generated and the resultant castings will be "blowy." Actually a certain amount of steam is always produced, the removal of which must be taken care of by ensuring that the moulding sands are of sufficient porosity and that the moulds themselves are adequately vented. None of these precautions are necessary, at least not in anything like the same degree, when dealing with Cast Iron, but they are all of the utmost importance and absolutely essential in order to produce sound steel castings. The above remarks embrace the more important differences between molten iron and steel, and the author will now attempt to outline the various commercial processes by which steel can be made.

Various Methods of Steelmaking

There are really five orthodox processes for making steel, namely the Crucible, Bessemer, Open-Hearth, Electric and High-Frequency. These are given in more or less the chronological order of their development, the Crucible Process being invented in Sheffield, England, nearly two hundred years ago, whilst the High Frequency furnace was first used on a commercial scale by Messrs. Edgar Allen and Co., Ltd., also of Sheffield, as recently as 1927. Steel castings can be produced by any of these processes, but in point of fact, for reasons subsequently explained, Open-Hearth and Electric Furnaces are responsible for probably 75 per cent of the world's output to-day.

The Crucible Process is not really a steelmaking one in the strict sense of the word, as small charges of around 60 lbs. of very pure and expensive scrap are merely melted down in individual clay pots, no refining reactions taking place. As can be appreciated, this is a small scale and costly operation, and whilst it still retains an important position as regards the manufacture of certain steels such as High Speed, Tool and Cutlery steels, it may be ignored as being generally unsuitable for the commercial production of castings.

The Bessemer Process is also nearly 100 hundred years old, and, although not so widely used to-day, a modification of it, known as the Steel Converter, has certain distinct advantages for use in the iron foundry. The principle of the process is the conversion of molten pig-iron into steel by blowing air through or over it at high pressure. The Oxygen in the blast oxidizes the excess Silicon, Manganese and Carbon very rapidly, and these reactions being exothermic, sufficient heat is thereby produced to keep the charge molten. Since the initial charge is molten iron, it will be apparent that the Converter is very suitable for working in conjunction with the ordinary Cupola, but in practice it is found that owing to the large amount of Iron Oxide which must be formed by this process, the resultant quality of the steel produced is not always all that could be desired.

The Open-Hearth Process is, in the main, a large-scale operation, furnaces of 30 tons capacity being considered quite small to-day. (It is sometimes called the Siemens Martin Process, after the names of its co-inventors). The furnace itself is a regenerative, reverberatory one, the name being derived from the fact that the hearth is open or exposed to the action of the flame. The gas (manufactured in special producers), together with the air, enter the furnace by means of individual super-imposed ports at one end, and, sweeping across the shallow hearth on which the charge of pig-iron and scrap is placed, leave the furnace at the opposite end. The spent gases are then led through the regenerators which are chambers filled with neatly arranged fire-bricks known as checkers, the function of which is to absorb the waste heat before the gases reach the stack or chimney. About every half hour, by means of special valves, the furnace is reversed, the incoming gas and air, pre-heated by passing through the incandescent checker-bricks, now entering the furnace at the other end. By means of constant reversing in this manner, the thermal efficiency of the system is gradually boosted up to a high degree. The Open-Hearth Furnace is really the standard mass-production unit of the big Steel Works and the greater part of its output is cast into rectangular moulds, the resultant steel ingots forming the base material for the forges and rolling-mills. Most Steel Works possess a foundry adjacent to the Open-Hearth Melting Shop, from which they can always obtain their supplies of molten steel for castings as and when required. Since the Open-Hearth Process is a continuous one, in other words when once started up the furnaces cannot be economically shut down, the process is obviously seldom adaptable to foundries where the main product is Cast Iron and where the demand for Cast Steel is only intermittent.

The Electric Furnace is by far the most suitable and therefore most widely used unit for the production of steel in the foundry. These furnaces can be obtained in a variety of designs and sizes, and the heating can be either by induction or resistances, the latter system being by far the more common. It is essentially a scrap process, in which the charge forms part of the regular circuit, the resistance it offers to the path of the current producing sufficient heat to eventually melt it. Admittedly, the installation costs are high, the majority of these being in connection with the electrical equipment, *i.e.* transformers, etc., required. Its advantages however, are considerable, the most important being its flexibility, both as regards the quality and quantity of its output, and its adaptability, in that it can be started up and shut down merely by the manipulation of a switch,—a very important consideration for the intermittent and hurried jobs which form so large a part of the small foundry's business. Under proper technical supervision, this process is capable of very close chemical control, and to-day, Electric Furnaces are producing a vast tonnage of high quality steels of almost every specification.

The High-Frequency Process, as its name implies, is also an electrical method. Incidentally, the writer was present at the demonstration of the first furnace of this type, when, early in December 1927, a 400 lb. charge of steel scrap was melted and cast in considerably less than an hour at the Works of Messrs. Edgar Allen and Co., Ltd. of Sheffield, England. In many ways, the process is comparable with the original Crucible Process, as specially selected scrap is re-melted in refractory pots. These pots, however, instead of being heated by coke or gas, are actually wound with a helical copper coil through which is passed a high-frequency current. By this means a secondary current is induced in the charge itself, the latter thus being melted under practically ideal conditions, since there is an absence of contamination by fuel or the products of combustion unobtainable by any other known method. Since, however, the special electrical equipment required is even more complicated and expensive than that of the ordinary Electric Furnace, this process can only justify its adoption where there is a demand for Special Alloy Steels, such as Cobalt, Tungsten, High Chromium and High Manganese Steels. That the process is finding a special field of its own is evidenced by the fact that at one of the Works of the United Steel Companies, Ltd., also of Sheffield, a complete plant has recently been installed containing a 2-ton and a 5-ton High-Frequency Furnace for the production of Special Aircraft, Automobile, Heat-resisting, Stainless and Magnet Steels.

The foregoing remarks constitute a very brief summary of the various commercial processes available to the prospective steelmaker. There are, however, a number of other very vital factors needing careful consideration before a wise choice can be made, the more important of which the writer will now attempt to enumerate.

Acid or Basic Operation

Each of the forementioned processes, with the exception of the original Crucible Process, can be operated in either of two ways. If the furnace, whether a Bessemer-Converter, an Open Hearth or an Electric one, be lined with silicious materials, (Silica-sand or ganister), it is said to have an Acid lining and its product will be Acid Steel. If, on the other hand, the furnace is lined with Dolomite, (Magnesian Limestone) or Magnesite (Magnesium Oxide), or both, it is Basic lined and will produce Basic Steel. The reason for these alternatives is purely a chemical one, the resultant product being virtually the same in both cases.

As previously mentioned, the steelmaker's enemies are Sulphur and Phosphorus, and the presence of either of these elements in amounts exceeding 0.06 per cent may have a serious effect upon the mechanical properties of steel. In any case it is always desirable to keep the amounts of these elements as low as possible, and their percentage, as revealed by subsequent analysis, is always, to a great extent, a measure of the quality of the steel.

Phosphorus in particular, and Sulphur to a great extent, can only be effectively removed from molten steel by the introduction of Calcium Oxide (Lime). In the presence of a slag rich enough in Calcium, and under suitable condition as regards temperature and equilibrium, the Phosphorus can be held in this slag as Calcium Phosphate and the Sulphur subsequently as Calcium Sulphide. This is putting the matter in its simplest form—actually the chemical reactions necessary to effect these changes can only take place under definite furnace conditions, the obtaining of which is part of the steelmaker's skill and technique. At the moment, however, these chemical considerations are somewhat beside the main point, which is the reason for, and not the manipulation of Acid or Basic Operation.

Since the oxide of Silicon, *i.e.* Sand, is Acid in its reaction, and the oxide of Calcium, *i.e.* lime, is strongly basic, these two substances cannot be used together under furnace conditions. In other words, at elevated temperatures the one fluxes the other, and if much lime were introduced into an acid-lined furnace, a thin watery slag would be produced which would be quite incapable of refining the molten charge, and would, moreover, quickly cut away the hearth and banks with serious consequences.

From these observations it will thus be seen that the question of acid or basic operation really depends on the supplies of raw materials which are going to be used for the furnace charges. We have seen that for the Bessemer Process the charge is wholly pig-iron, for the Open-Hearth it is roughly 30 to 40 per cent pig-iron with the remainder steel scrap, whilst for the Electric Furnace it is wholly steel scrap.

Acid operation, therefore, since no Sulphur or Phosphorus can be eliminated, can only be used where a regular supply of reasonably good pig-iron and steel scrap can be obtained. With the Open-Hearth Furnace the sulphur and phosphorus contents of the entire original charge should not exceed 0.040 per cent as a certain amount of Sulphur can, under certain conditions, be absorbed from the Producer Gas. With the Electric Furnace there is of course no danger of this kind. It is largely because low Sulphur and Phosphorus scrap is necessary for acid operation that Acid Steel acquired the reputation of being the better quality and for many years it was exclusively specified in all the more important specifications. To-day, however, in the light of modern research and highly-specialized melting practise, this statement is very controversial.

Basic operation, conversely, becomes imperative when the supplies of raw materials are of mixed quality or of doubtful origin, since, in order to obtain good quality steel from which the normal tensile and ductility values may be expected, both the Sulphur and Phosphorus contents should not exceed 0.050 per cent. The Basic Process is often more expensive since the cost of the special refractories needed is not always offset by the lower cost of the inferior scrap which can be used. Also, being a double-slag operation, the time taken for a melt is usually longer, meaning a greater power (*i.e.* electricity) consumption. A very great number of the big Open-Hearth installations are to-day producing Basic Steel because of the present preponderance of phosphoric iron ores which, when melted, produce, of course, high phosphorus pig-iron. As previously stated, if properly conducted under efficient technical control, the final results obtained by this process are analytically and mechanically identical with the other, and in the writer's opinion, the much talked of inferiority of Basic Steel is largely hypothetical.

With regard to the production of ordinary Carbon Steel Castings, the general consensus of opinion and practise is in favour of the Acid Electric Process whenever possible. Where there is a demand for Steel Castings there are usually engineering shops in the vicinity from which a certain amount of steel scrap in the form of turnings, plate punchings and parings can be obtained. The turnings at any rate will be almost certain to be suitable for re-melting, but samples of the plate scrap should be frequently analysed, particularly with regard to the Phosphorus content. It might here be mentioned that the writer was quite recently making Acid Electric Steel castings in a progressive Ironworks in the West of Canada. The majority of these were for the Canadian Pacific and Canadian National Railways, and had to be tested and passed by their own inspectors. The only scrap available was from their own works and consisted of turnings from the machine shops and plate scrap from the constructional shops, and at one period a steadily increasing Phosphorus content in the final melting tests was reported from the Laboratory. The cause of this was eventually traced to a consignment of Belgian steel sheets which were being used for the construction of grain elevators, the punchings and parings from the sheets averaging around 0.070 per cent Phosphorus. Fortunately a supply of discarded axles and tyres of Sheffield origin was available at the adjacent C. P. Railway shops which analysed around 0.040 per cent Sulphur and Phosphorus and by suitably diluting the charges with this material the phosphorus content was kept within safe limits. In such ways it will generally be possible to find supplies of raw material, *i.e.* steel scrap, suitable for the Acid Electric Furnace, and only when this is not practicable should the Basic Process be employed solely for the production of ordinary Carbon Steel Castings. It should here be mentioned that certain alloy steels, particularly the Stainless and Manganese Steels (on account of the high percentage of special alloys required and of certain slag reactions encountered in consequence), can only be made satisfactorily by the Basic Process, but the production of these steels is mostly in the hands of specialists, and the general steel-founder is not likely to be troubled with, nor should he attempt to contend with, enquiries of this nature.

Chemical Reactions in Steelmaking

Steelmaking is largely a study of the cause and effect of certain oxidizing and reducing reactions, and it therefore follows that the competent steelmaker should have a sound knowledge of chemistry. As it is seldom that the actual furnacemen possess these qualifications,—although the tendency to-day with its ever increasing educational facilities is definitely in this direction,—the control of the melting should always be in the hands of an experienced steel-chemist, who in small plants is usually responsible for the equipment and running of the Laboratory as well. To attempt to make steel on a commercial scale without scientific control is simply asking for trouble, and whenever possible, technical advice should be procured in advance of the equipment. To go thoroughly into the various reactions which take place during the melting and refining of molten steel is beyond the scope of this Paper, but the following remarks are an attempt to outline briefly but accurately the fundamental principles involved in the various methods of making steel.

Keeping to the original sequence of processes, it has been pointed out that the charge in the Bessemer Furnace, known in its smaller sizes as a Steel Converter or Baby Bessemer, consists wholly or mainly of molten pig-iron. After receiving this charge the furnace or vessel as it is called, is turned up and air under high pressure is blown either through the metal (bottom-blown) or across its surface (side-blown). The Oxygen in the air blast combines rapidly with the excess Silicon, Manganese and Carbon in the order named, and since all these reactions, particularly the oxidizing of the Silicon, are exothermic, sufficient heat is generated within the vessel to keep the metal fluid enough for casting. The oxidation products are, of course, SiO_2 and MnO, which form a slag, the Carbon first becoming CO, but later burning at the vessel's mouth to CO_2. It will appear from the above description that the conditions within the vessel are at all times intensely oxidising and since Iron (*i.e.* Fe) is itself a readily oxidizable element, it will also be appreciated that a considerable amount of FeO must be formed, and it is the inevitable absorption by the bath of a

great deal of this harmful Iron Oxide that often causes steel made by this process to be unsatisfactory. As regards the Sulphur and Phosphorus, there is, of course, no elimination of these elements if the vessel is acid lined ; if on the other hand a Dolomite (Basic) lining is put in, enabling lime to be added with the charge, the whole of the Phosphorus is oxidized to Phosphoric Acid during the "after blow," and can be retained as Phosphate of Lime in the slag. The removal of Sulphur in the Basic Bessemer Process is only partial and always somewhat erratic. A certain proportion of the element remains in the slag as Calcium Sulphide and Manganese Sulphide, but it is always advisable to keep the Sulphur content in the initial charge as low as possible. Reviewed briefly, the advantages of the process are its quickness (the whole operation takes only from ten to fifteen minutes), its cheapness and its suitability for intermittent operation, but these points cannot really compensate for its inherent disadvantages, namely the saturation of the steel with oxides and the heavy melting and blowing losses (nearly 20 per cent).

In the Open Hearth Process, since the charge remains in a molten condition for several hours, there is much scope and opportunity for many important and controlled chemical reactions to take place. During the first part of the operation in which the charge of Pig-iron and scrap is being melted down, the Carbon, Silicon and Manganese therein are gradually eliminated by adding Oxygen to the bath usually in the form of Iron Ore (FeO). At furnace temperatures, this ore splits up into Fe, (which is retained in the bath), and O, this liberated Oxygen combining with the Carbon to form CO, and with the Silicon and Manganese to form SiO_2 and MnO respectively. These last two oxides together with some FeO, of course, form a slag through which the CO breaks, the bubbles thus formed marking a definite period of the operation technically known as "the boil." In this way, by careful ore additions, the Carbon is gradually "boiled" out until it is low enough to meet the specification of the particular steel required. This point is determined by means of spoon samples taken at intervals from the bath. By quenching and breaking these samples, an experienced melter can, from the appearance of the fracture, follow the falling Carbon content fairly closely, but when the specification limits are approached, quick and accurate colour tests are made on the spot by a steel chemist. When the Carbon has fallen a few points below the upper specification limit, the bath is deoxidized by additions of Ferro-Silicon. Silicon, having a great affinity for Oxygen, thus cleanses the bath, the product of the reaction, SiO_2, entering the slag which in consequence thickens up at this point. If the slag becomes too viscous towards the end of the melt, small additions of limestone or lime will quickly increase its fluidity. The writer would here like to emphasize the fact that at all times during Open Hearth (and Electric, as will be seen later) steel-melting the formation, composition and equilibrium of the slag is of the utmost importance. A very erroneous idea frequently met with is that the slag is merely an unnecessary scum which automatically forms during the melting. In this connection the writer has never forgotten a remark made to him some twenty years ago by an old Sheffield melter to the effect that "if the slag was alright the steel would be alright," a statement which invariably proves correct. The slag, in fact, has two extremely important functions to perform, one to protect the molten metal from outside contamination (in Open Hearth melting, chiefly oxidation and absorption of Sulphur from the Producer-Gas) and the other to absorb and retain the impurities and metalloids which must be eliminated from the charge in order to obtain good clean steel. On an acid hearth there is no removal of Phosphorus or Sulphur, in fact there may be a slight increase in the latter, so that good quality scrap is essential for the charge. On a basic hearth with a good limey slag of the right composition and consistency practically the whole of the Phosphorus and most of the Sulphur are readily removed from the charge. In a number of Basic Steel plants the Phosphorus content in the furnace charges is purposely boosted up by using high Phosphorus (Basic) Pig-iron in order that the finishing slags may be rich in Phosphate of Lime, which makes them a marketable by-product used in the manufacture of fertilizers. As regards the Sulphur, that in the slag will be retained there as Calcium Sulphide, but the small residue which is always left in the steel can be present as either Iron Sulphide or Manganese Sulphide. As it is now known that the former is far more harmful than the latter, and since Sulphur has a stronger affinity for Manganese than for Iron, sufficient Ferro-Manganese should always be added at the conclusion of the melt to yield 0.60 to 0.80 per cent Mn in the finished Steel.

The Electric Furnace Process is definitely a step nearer towards ideal melting conditions, since the charge can suffer no direct contamination from coal, coke, oil or gas. Also since the furnace itself is of very compact design, almost completely oxidizing or reducing conditions can be obtained and maintained at will during both the melting and refining periods. As previously mentioned, this method of making steel is essentially a scrap process, and since electric furnaces are generally hand-charged small-capacity units, this scrap must be selected accordingly. Concerning the question of capacity, in the writer's opinion it is a great mistake to start with too small a furnace. A small heat, say one ton, can always be made in a three-ton furnace, but the limits to which a one-ton furnace can be safely overloaded are very problematical, and many failures and much bad steel can be attributed to this risky practise. The reactions which take place in Acid Electric steel-making, which is the normal standard practise for the production of ordinary mild steel castings, are fairly straightforward. When the bath is clear-melted a spoon test is taken and quickly analysed by the Chemist for Carbon and Manganese. If these are found to be too high for the specification required, small additions of Hematite (low Sulphur and Phosphorus) iron-ore are made and further tests taken at intervals until the Carbon is two or three points lower than the required limits. After these additions the metal will be found to be "blowy" or "wild" due to the Oxygen introduced by the Fe_2O_3 (Iron Ore). The bath must now therefore be deoxidized or "killed," this being effected by the usual method of adding Ferro-Silicon, the Silicon therein attracting the surplus Oxygen with the formation of SiO_2. Spoon samples from the bath should now break under the hammer only with difficulty, exhibiting great toughness and a very fibrous fracture free from blow-holes. When this stage has been reached and both the temperature of the metal and the appearance of the slag adjudged to be correct, the Ferro-Manganese additions are made and the furnace tapped. If the Sulphur and Phosphorus contents in the finished steel exceed 0.05 per cent, either a proportion of better scrap must be included in the charge or the Basic Process must be used. This necessitates, of course, a complete lining of the special refractories Dolomite and Mangnesite which enables the heat to be worked under a lime slag. Incidentally, the writer has observed during his fifteen months' experience in the East, that abnormal climatic conditions have a very marked effect on the behaviour of certain basic refractories, and in his opinion there is need for considerable investigation and experimentation in connection with their satisfactory use and storage during the frequent periods of excessive humidity. The Basic Electric Process is a double slag operation, the first or oxidizing slag being formed as the result of the fairly large additions of limestone and smaller amounts of iron-ore included in the charge. Under suitable melting conditions this slag will remove and retain as oxides practically all the Silicon, Manganese, Carbon and Phosphorus. When these reactions have been accomplished, this being determined by spoon tests and rapid analyses, this oxidizing slag is removed by the simple process of tilting the furnace and pouring it off into the slag-pit. This is followed by adding a mixture of lime, coke-dust and fluorspar, thus building up a deoxidizing slag on the surface of the molten metal. An important function of this finishing slag is to desulphurize the bath, the reaction being the formation and retention of Calcium Sulphide in the slag. When the bath has thus been properly deoxidized, as judged by the soundness and concavity of frequent spoon tests, the final Ferro-Silicon and Ferro-Manganese additions can be made and the heat tapped. From the above brief outline of operations it will be seen that the Basic Process is longer, more complicated and usually more expensive than the Acid, and it is therefore not recommended for the production of ordinary mild steel castings if reasonably low Sulphur and Phosphorus scrap can be obtained.

The High Frequency Process, as before mentioned, can only really justify itself, owing to its present high installation costs, where very special and uncommon steels are in demand. It is an almost ideal method of making steel and it is to be hoped that ways and means will eventually be found for cheapening it, but at present it is beyond the consideration of the ordinary routine Steelfounder.

(*Continued on page 378*)

Tokyo Subway Extensions

By *W. HARVEY CLARKE, Jr.*

TOKYO's meteoric rise from the ashes of early September, 1923, to emerge as second most populous metropolis in the world and to stand fifth in territorial magnitude among its cities, is visible proof of the resourcefulness and initative for a citizenry suddenly finding itself overtaken by destructive forces of nature.

During little more than a decade, thus, the Japanese Capital has demonstrated an inherent vitality through manifold developments and constant progress in city planning and building. Never before within the memory of man had a city of the size and the importance of Tokyo been called upon to shoulder the responsibility and face the grueling task of such extensive reconstruction as was hers. People from far and wide flocked by the thousands into the devastated areas to join hands in a common purpose—that of rebuilding in a bigger and a better way what had been ruthlessly destroyed before their eyes.

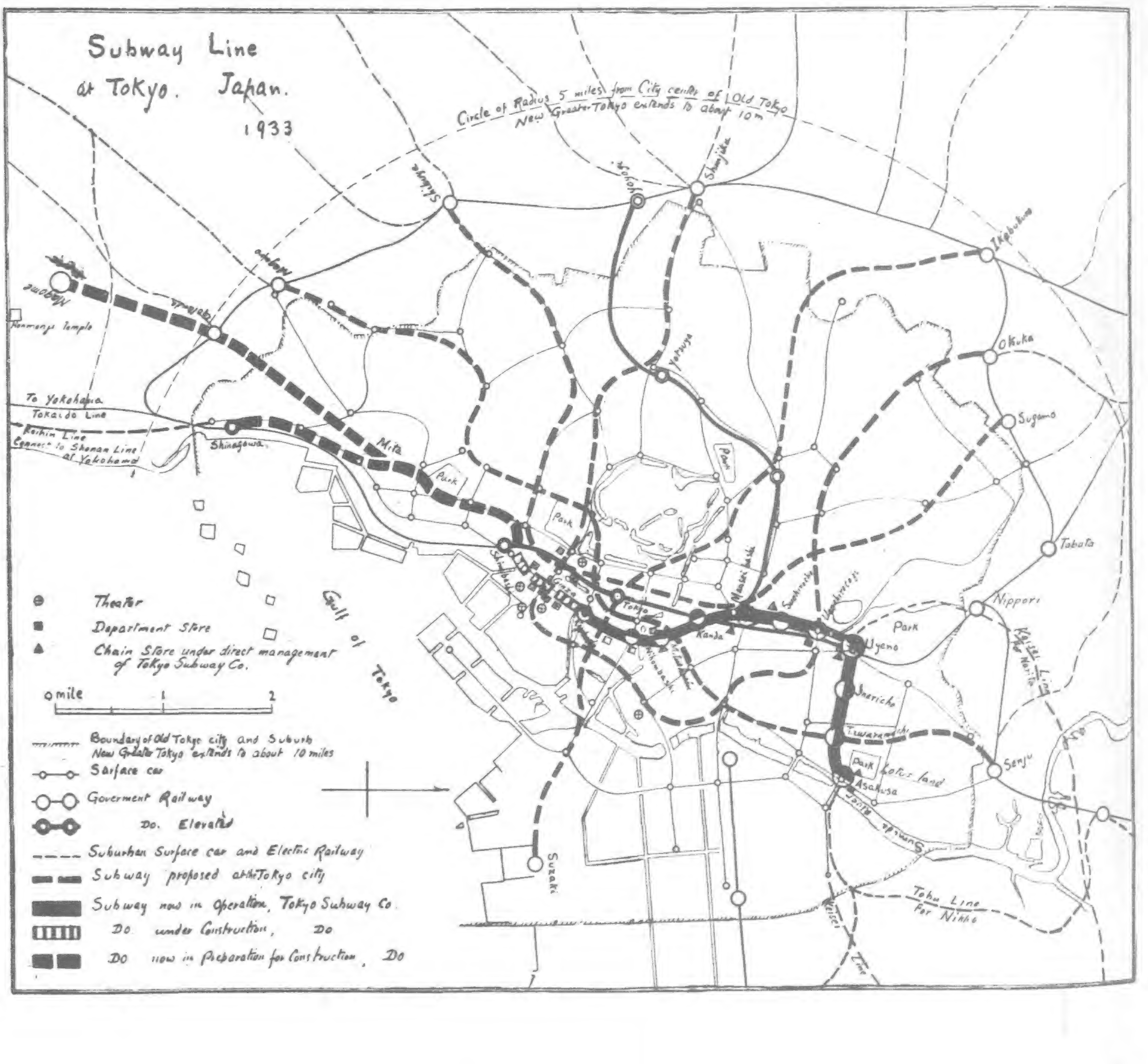
It was not until 1925 that actual underground railway construction was begun by the Tokyo Subway Company, Inc., to relieve surface traffic congestion and to facilitate rapid transit over long metropolitan distances. By Christmas Eve, 1932, the trunk line, starting from Asakusa Park in the north of Tokyo and traversing the heart of the city, extended for 4,002 miles (6,473 kilometers) to Kyobashi intersection in the south, as described in the April, 1933, number of *The Far Eastern Review*.

Next, Ginza Owari-cho Station was opened for service on March 3 last; and with underground passenger traffic mounting as each new section was added to the line, the company began to operate two-car steel trains at two and one-half minute intervals when Ginza, Tokyo's famous shopping center, was penetrated.

Shimbashi Station followed on the 26th of this month, and to-day a trunk route five miles long, linking 12 stations, is completed as part of Tokyo's underground transit projects. At Shimbashi, the subway meets the Elevated Beltline, which encircles the city by way of Shinagawa, Shibuya, Shinjuku, Ueno, Kanda, Tokyo Central Station and back to Shimbashi, where transfers to fast electric trains to Yokohama can be made. As traffic increases it is planned to put subway trains of three or more cars into service.

Many Conveniences

With every link added to its route, the subway binds closer together the far-flung districts of the city. Along its course the



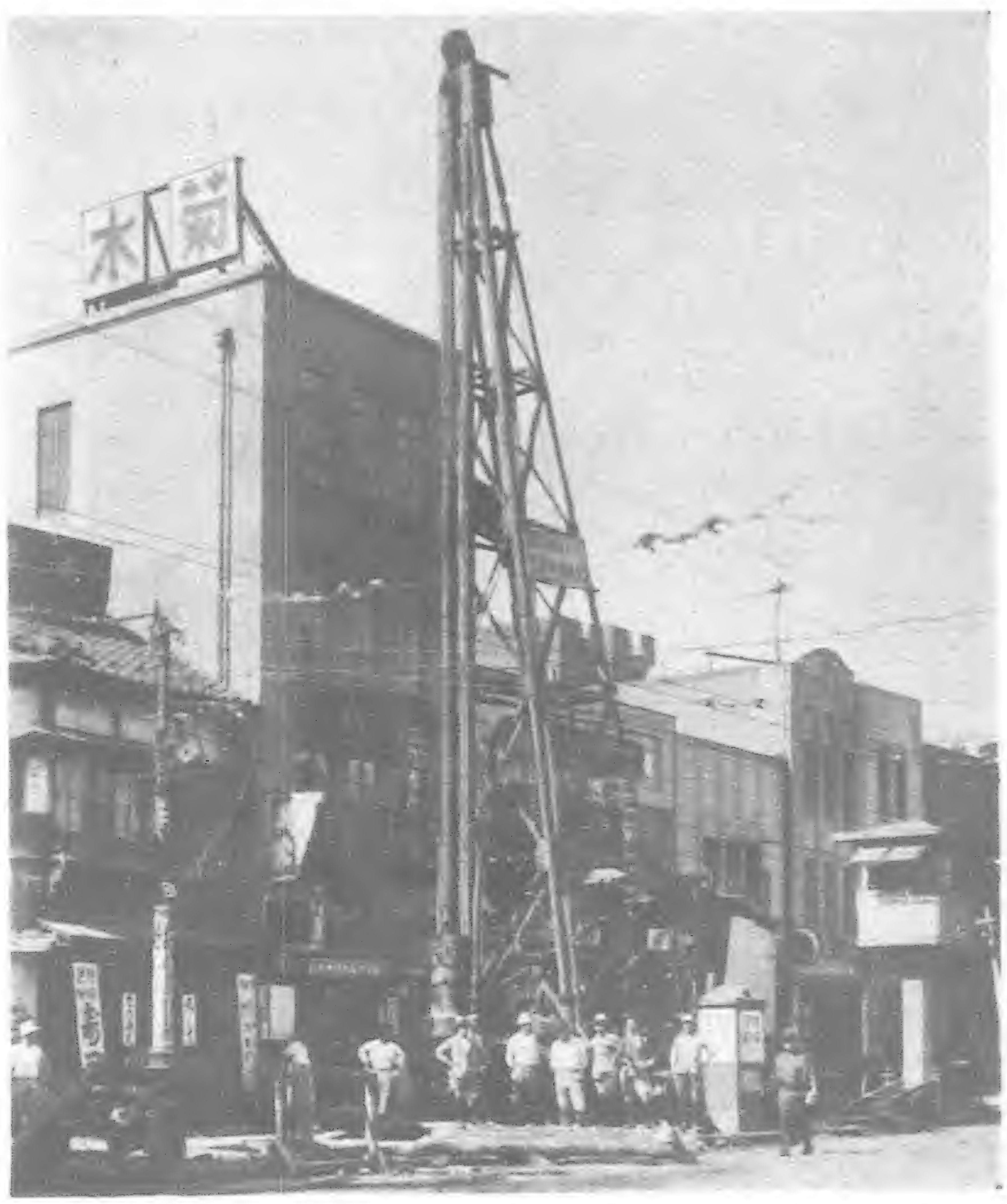
basements of many large department stores are provided with wide outlets to the mezzanine level—the spacious corridor or promenade—above the tracks. At some busy intersection stations, convenient sidewalk entrances and exits serve as underpasses beneath dangerous street crossings, thereby contributing materially to safer pedestrian movement. In the opening of this trunk line, the advantageous results of subsurface traffic facilities have been amply demonstrated to a public that soon came to recognize the subway to be not only an indispensable utility but also a remunerative undertaking. Company

Bird's eye view from Fukutoku Building of Kyobashi Bridge on Ginza, under which railway tunnel was driven. Canal is seen blocked off by coffei-dams on both sides of bridge.

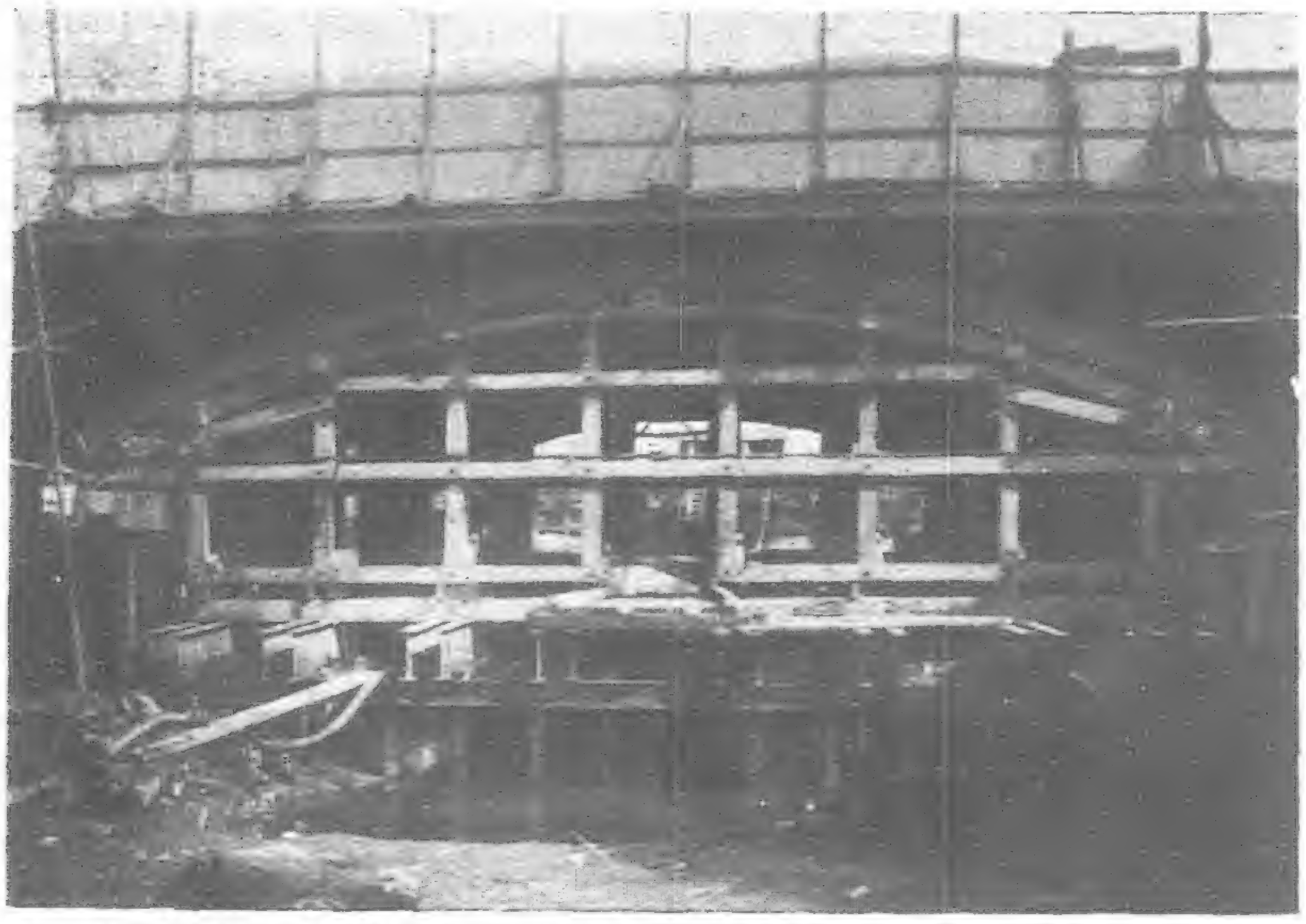
Scissors Crossing near Ginza Owari-cho Station ready for concreting. Switch rails are moved electrically—some by spring switching

Shimbashi Highway Arch Bridge at the beginning of Ginza, alongside which a temporary footpath bridge is being constructed to span canal, an initial step in subway driving beneath

View of subway tunnel under Kyobashi Bridge where double tracked concrete bed is separated by middle wall. Tunnel structure is of ferro-concrete

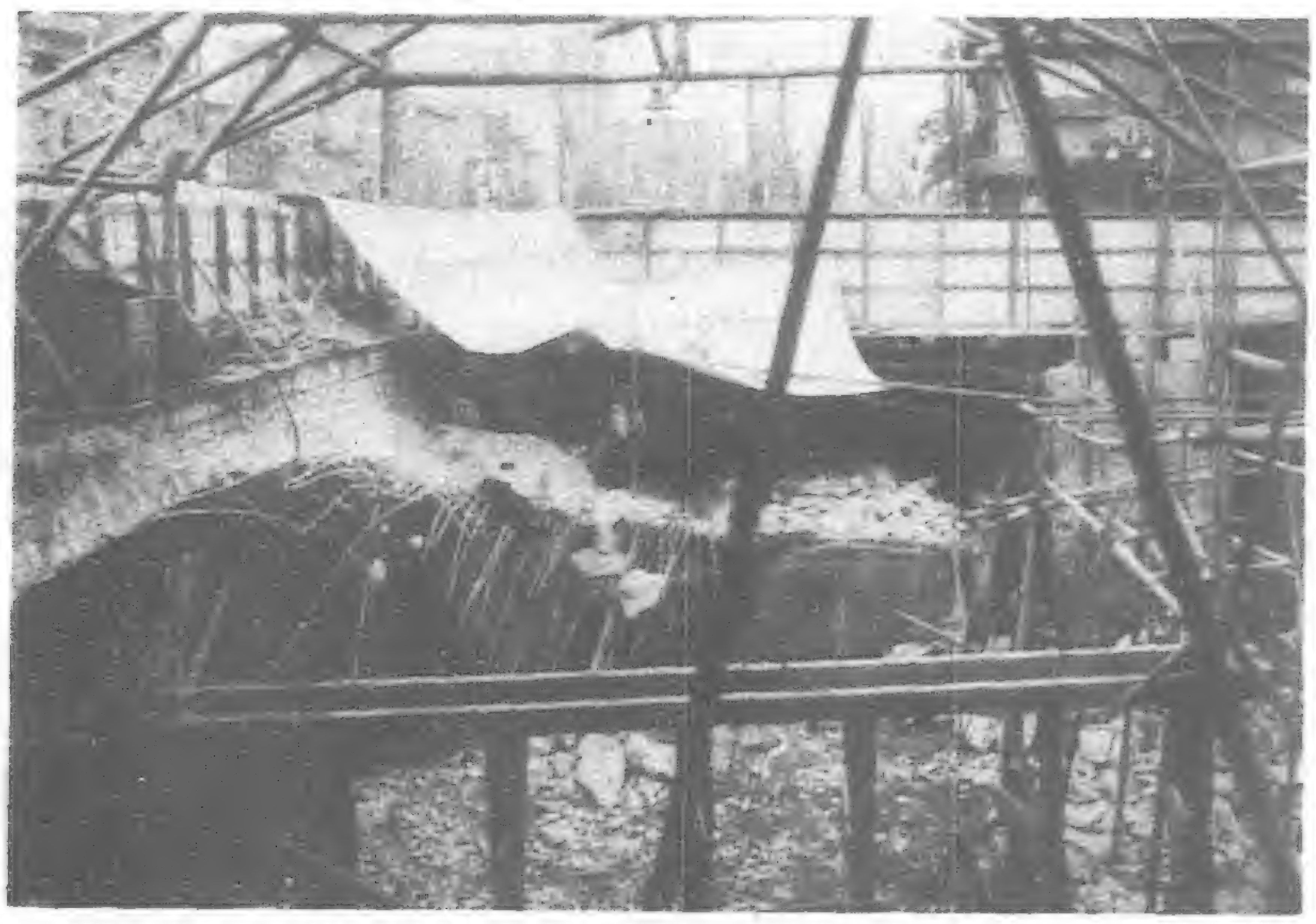


Steel I-beam pile-driving along Shimbashi section of subway, near Shimbashi Station on elevated beltline



Kyobashi Arch Bridge supported by scaffolding erected on canal bed. Bridge abutments were removed to enable subway tunnel construction beneath

Hoisting excavated earth on the Ginza Whiteway to be loaded and carried off in motor trucks



After Shimbashi Bridge was blocked off by coffer-dams, parallel footpath bridge was taken down. Bridge abutments here are in course of removal in preparing for construction of subway tunnel by open-cut method

Driving steel I-beam horizontally under building with hydraulic jack operated by gasoline engine. At first a small hole was bored with screw, then steel beam forced into ground. Three to five beams in 9-foot sections were connected end to end

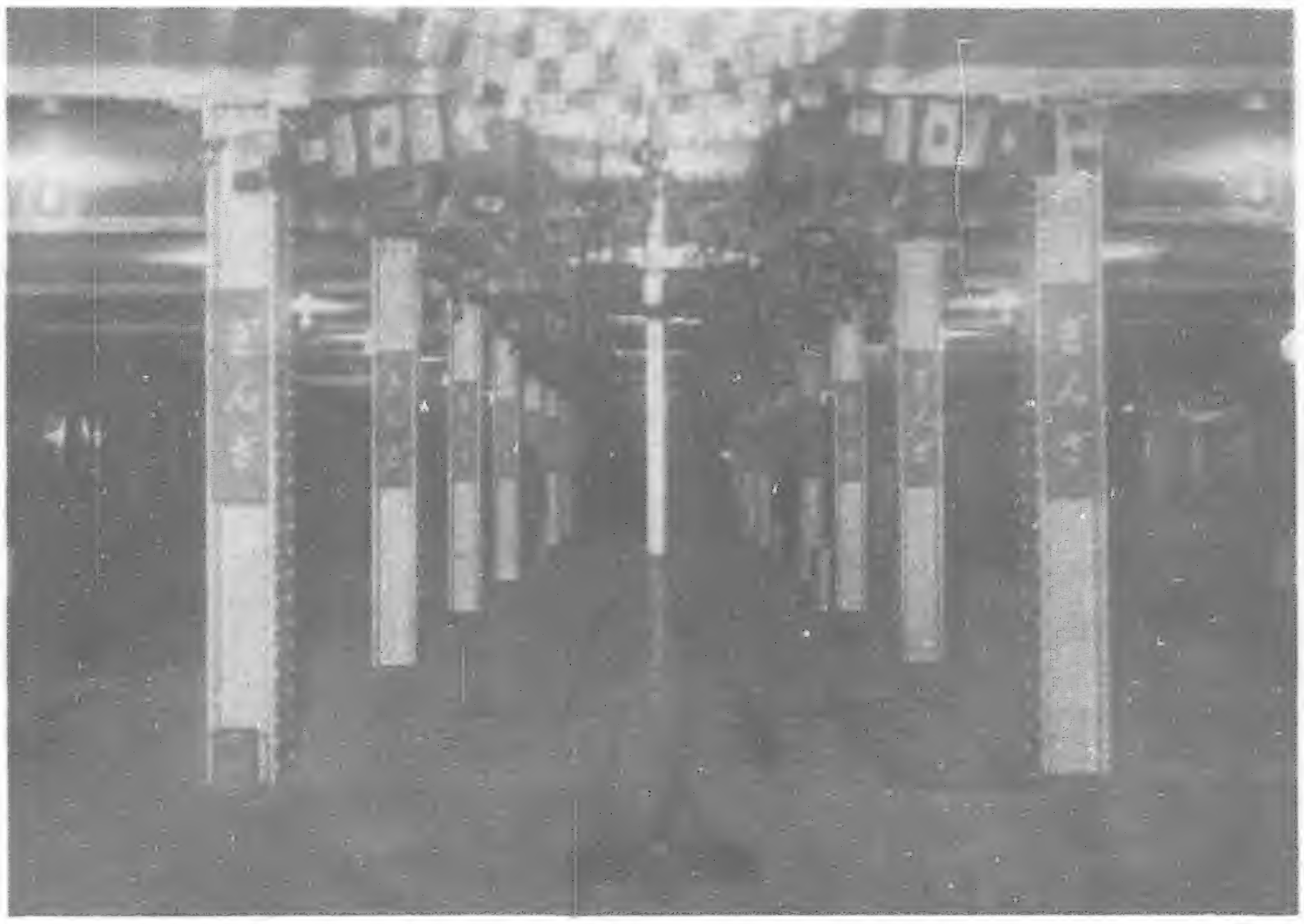
Steel I-beams were driven into ground horizontally at intervals of 3.3 feet. Beam-end was fixed to I-shaped steel pile driver and its lower part forced into side wall section of tunnel to depth of 16 feet horizontally and 27 feet vertically. Three buildings stood on ground surface 18 feet above top of horizontal beam

Spacious mezzanine floor level of Ginza Station where stairway connects with island platform below. When Subway station opened —March 3, 1934—this promenade level was decorated with artificial cherry blossoms. Ginza, the thoroughfare above is well-known for its willow-lined sidewalks

officials give assurance that hereafter further extensions of the line will follow one another more quickly than they have in the past.

The total length of the underground rapid transit system planned for Tokyo is approximately 50 miles—a part of which is being undertaken by the Tokyo Subway Company and a part under projection by the city of Tokyo. Owing to financial difficulties, the municipality's plans are still in a tentative state, but other plans are on foot for a private organization to begin construction independently in the near future.

In many of the leading cities of the world, capital invested to accommodate local passenger transportation is to a major extent supplied by the municipalities themselves, there having been a tendency to let some portion of the expense fall upon city revenue—and indirectly upon those whom the facility serves. Tokyo, however, is unique in having attempted through private investments alone, without any form of subsidization, as in the case of the London Tube, the construction of the latest type of subway system. Well-earned success seems to be in store for its promoters.



Ginza Station island platform on opening day, March 3, 1934.

Kyobashi-Shimbashi Section

Covering a distance of about a mile, this section has two stations—one at the Ginza Owari-cho intersection and the other at Shimbashi Station—both having extra long 300-foot island platforms and the wide mezzanine type of underground corridor. The method of construction and the design are in accordance with the company's standard procedure; but tunnel borings under two canals, driving beneath shop buildings at Shimbashi and preparatory work for an intersecting subway line at Owari-cho sometime in the future are worthy of description.

One of the eight entrances to Ginza subway station which lies directly beneath Owari-cho intersection. Wide underpasses connect all entrances and exits

Kyobashi Canal Tunnel Construction

The subway tunnel in approaching Kyobashi Canal passes directly under Kyobashi Bridge, a flat ferro-concrete arch type structure having steel arch ribs with a 55-foot span. In order to construct a box-shaped double-track tunnel by the open-cut method, the canal water was blocked on both sides by cofferdams. Two rows of sheet steel piles were driven to break open part of the bridge, and this broken area was covered with wooden decking. After the bridge arch was put under support of wooden scaffolding erected on the canal bed, bridge abutments were removed. Excavation having been accomplished, a ferro-concrete tunnel structure with a middle partition wall was constructed, and then the abutments were replaced, being built back upon the tunnel roof. This section under Kyobashi Canal is about 190 feet in length.

Shimbashi Canal Tunnel Construction

The subway tunnel structure at this point passes directly under the west sidewalk portion of Shimbashi; a flat reinforced concrete arch type bridge having a clear span of 80-ft. To expedite operations, a temporary wooden footpath bridge, 11-ft wide and 92-ft. long, was built parallel to the west side of the bridge, and the sidewalk portion, including abutments, was taken away. As previously practiced during subway construction under other canals and rivers, the water was held back by cofferdams. Sheet steel piles were again driven on both sides of the tunnel and excavation was carried on by the open-cut method as before. A ferro-concrete box-shaped double-track tunnel, combining a series of steel supporting posts and a partition wall separating the tracks, was constructed. Finally, the removed portion of the bridge was restored above the tunnel roof. The length of the tunnel section here is 178-ft.

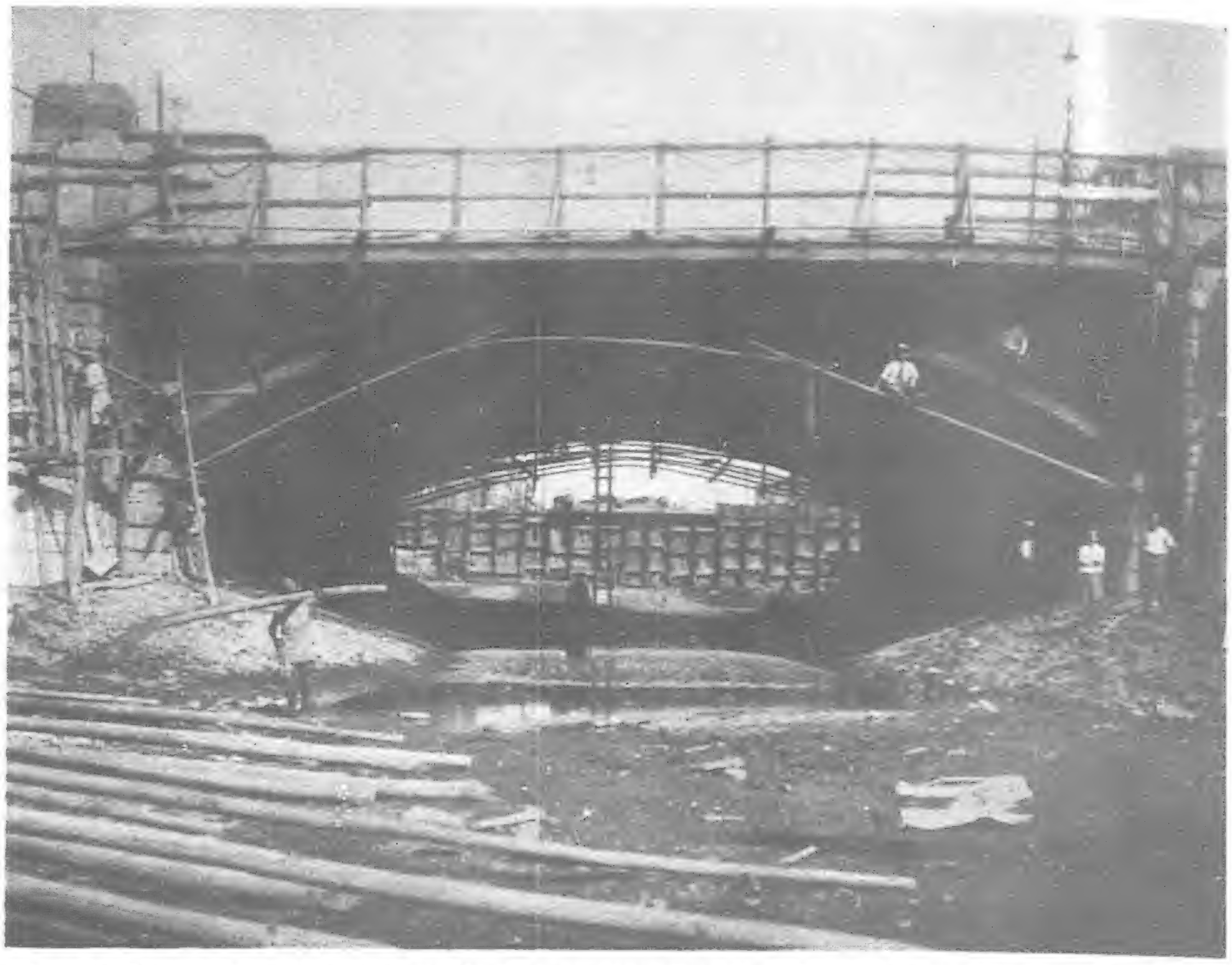
Subway Driving Underneath Shop Building

Where the right-of-way makes a relatively sharp turn in the curve between Shimbashi Bridge and Shimbashi Station, one-half of the tunnel's width passes underneath an area covered by three wooden shop buildings. Here the top of the tunnel lies about 23-ft. below the surface of the ground. Two rows of steel I-beam piles were driven at intervals of 3.3 feet—one row running alongside the tunnel and the other directly in front of the three buildings. The street surface between the piles was covered with wooden decking. After excavating under this decking to a depth corres-

ponding to the tunnel roof, steel I-beam transverse piles were driven horizontally with hydraulic jacks at intervals of 3.3 feet. one end of which were fixed to the steel piles parallel to the buildings as supports for them, as well as to resist pressure from the earth.

After excavation beneath the street decking and the horizontal pile supports was completed, 17 sets of steel frames placed at intervals of 5-ft. were enclosed with reinforced concrete in forming a box-shaped double-track tunnel with steel posts along the mid-part. Then, the horizontal pile supports paralleling the tunnel structure and bearing the steel piles in front of the three buildings were cut off.

The geological character of this part of the route is precipitate stratum at the surface, the earth further down consisting of tertiary formations of sand and shale. Consequently, an unique method of excavation, such as that employed, instead of underpinning, was conducted with no damage to the three buildings on the ground surface. The structural steel frames put up along this section of the line were of extra heavy construction—a single set weighing 13 tons. They were used in anticipating the pressure exerted by eight-story buildings that might sometime be erected on the site.



Kyobashi subway tunnel section completed under bridge spanning canal. After painting steel arch ribs and clearing canal bed, coffer-dams were removed to let water flow back as before construction began

Incidentally, the work entailed involved the meeting of a hydrostatic head of between 19 and 26-ft. of a pressure per square inch of between 8 and 11 pounds and, it is surmised, a lifting power per square inch under the subway floor of between four and six pounds. Naturally consideration was also given to the problem of the effect of frequent earthquakes upon the kind of waterproofing specification employed. This ruled out the use of waterproofing by means of chemicals to be mixed with concrete, as such a procedure gives no protection in case of cracking caused by earth movements, or protection against contraction of the structure or other bodily structural movement.

Final specifications decided upon for the bulk of the waterproofing work of the Tokyo subway, called for three layers of Jute Burlap for the sides, or walls, of the tunnel and two or three layers of the same material for the bottom, or floor, and the ceiling of the tunnel, each layer being carefully and thoroughly mopped with hot asphalt so as to render the whole quite waterproof. Protection for the waterproofing material was obtained by means of pouring a thin layer of concrete over the installed waterproofing.

Another Line to Intersect Ginza Station

The proposed subway route of the Tokyo Municipality passes crosswise underneath Ginza Owari-cho Station. It was foresightedness, therefore, when Ginza Station was under construction, that prompted the Tokyo Subway Company to provide for the necessary station width and depth needed in driving a future intersecting line. This advance work has eliminated the expense that would have been required in excavating for another underground structure beneath the present station. A part of the future station, 56-ft. long, having side platforms to connect with Ginza Station and corresponding to its width, was built under it for future utilization.

Celebration Gathering

The completion of the central trunk line of the Tokyo subway demanded unusually sound engineering ability because of the diverse topographic and geologic features encountered in its construction. Since the beginning of work at the northern terminus of the line at Asakusa Park in 1925, it has taken some nine years to drive the subway along its present five-mile course. It was Tokyo's initial attempt at underground railway engineering, but the obvious success achieved has induced plans for rapid extensions in the future, so that a network of underground transit lines will be a reality in the comparatively near future. Such were the reasons for the company's decision to celebrate after June 26 the event of the opening of Shimbashi Station, the present southern terminus of the subway, by inviting to a mass meeting several thousand men and women of prominence in various circles of Tokyo society.

To Link Ceylon and London

Wireless telephonic connection between Ceylon and London and with other parts of Europe and even the United States of America is likely to become possible before the end of this year.

It will also very probably be possible for Ceylon this year to join in the broadcast of Christmas Day greetings between different parts of the Empire.

The information was communicated by the Postmaster-General, Mr. J. R. Walters, in reply to an inquiry on the subject.

This development will become possible not as a result of the installation of a beam wireless station in Ceylon. No such installation is necessary for the purpose.

The Postmaster-General explained that for the purpose of affording Ceylon a wireless telephonic link with London and through London with other parts of the world it would be sufficient if Ceylon had ordinary telephonic communication with India.

That facility was now being supplied. The new cables that would shortly be laid between Talaimannar and Danushkodi, as was known, contained also telephone wires.

Information was now being awaited from the Indian authorities on the subject of connecting these telephone wires with their land lines. Once that connection was established and the Ceylon Government laid land telephone lines between Colombo and Talaimannar linking the cables, wireless telephonic communication would also be feasible.

When the telephone link with India was complete, as it was bound to be this year, any person in Colombo desiring to call up a London telephone number could get a trunk call to the beam station at Karachi and through it to Daventry. The latter could easily put the Ceylon caller in communication with any telephone number in England.—*Ceylon Daily News.*

Water Supply in Hongkong

The Story of a Triumph of Applied Science

By *Professor C. A. MIDDLETON SMITH, M.Sc., M.I.Mech.E. (Dean of the Faculty of Engineering in the University of Hongkong)*

PART II.—INCREASING THE STORAGE AND AREAS OF SUPPLY ON THE ISLAND

In a previous contribution a general survey of the various problems connected with water supply in general, and the peculiar local conditions in Hongkong, was given. It is now proposed to deal in detail with the water supply on the island.

If we assume that the desirable quantity of water available per head per day throughout the year averages 20 gallons, and calculate for an increase in the existing numbers of inhabitants on the island to a maximum of 500,000 people, then the amount of water required comes to a total of 10 million gallons per day. At the present time the population on the island using water from the public supply is about 400,000 ; and eight million gallons per day is the probable maximum demand, at present. Until the works now under construction are completed it will be impossible to provide that supply. And therefore at certain periods of the year water restriction is ordered by the Government.

"Fragrant Streams"

With the restriction now in force (the supply is cut off for some hours out of the 24) the supply was in May (1934) at the rate of seven million gallons a day from the Tytam system of reservoirs. This was supplemented by water from the mainland.

The story of the growth of the storage capacity, the increase in area of catchments, the improvement in filtering and distribution of water in Hongkong, is a story of great interest to those who know anything about the difficulties associated with such problems, especially in the tropics. And it is important to realize how, at an all-increasing expenditure, the present supply system has been built up, and is being improved.

The correct translation of the words "Hongkong" is said to be "Fragrant Streams". Before the island was a British Colony (1841), sailing ships, trading with Canton, often landed parties on Hongkong to collect water from the "Fragrant Streams". Probably the well-deserved reputation which the place had gained for providing good drinking water was a matter which was taken into consideration when the British were requested in 1841 by Chinese officials to select for their trade headquarters one of the then more or less barren islands at the mouth of the Canton river.

On the Northern side of the island—the side directly opposite Kowloon, where the City of Victoria, the business center, has been built, many of the hillside streams have been "modernized". The water now no longer pours over boulders, orchids and ferns, leaving little pools wherein mosquitos breed. For "Nullahs", made of granite blocks and concrete, have been constructed so as to keep the streams within regulated limits. This has, perhaps, destroyed the natural beauty of the island waterfalls, but it has been of immense benefit to public health.

It has been said that if all of the "Fragrant Streams" of Hongkong were trained to carry the rains to reservoirs or to the sea, malaria would be entirely eliminated. On the North side of the island there has been a great reduction in the trouble caused by malaria because of the construction of these granite faced nullahs. They are of course, costly to build, but the results more than justify the expenditure. Unfortunately most of the water from these nullahs runs direct to the sea, and not into reservoirs, owing to difficulties of reserving catchment areas on the North side of the island, which is built over in many places.

On the South side of the island Nature has not been interfered with very much, because there are only a few residences there. You can see the little natural waterfalls, with the boulders, ferns, orchids and creepers on the banks. You can also see and hear and feel the mosquitos. The nullahs, built of granite and concrete, are, however, gradually replacing the natural courses. There are definite signs of building extensions all over the island.

In the Early Days

It was not until about 1861 that there was any real demand in Hongkong for a public water supply.

For about the first twenty years in the history of the British Colony the water supply arrangements were primitive. Water was led by pipes from the streams to houses, or carried in buckets from pools or streams on the hillside. Every house of importance had its own supply tank on the hillside, and, as far as we know, the supply was maintained during the dry season. But many inhabitants could not find the money to build a tank.

Each householder made his own arrangements, and the Government had no responsibility in this matter. In the early records of Hongkong we read of wells. The water supply also came from streams flowing down the northern side of the island. Five wells had been sunk by the year 1851, when the population, was 32,983.

As the numbers on the island gradually increased from the 5,000 of 1841 to the 50,000 of 1860, so did the necessity for a public supply of water become more obvious.

In 1863, there was completed the first effort in this direction. The original suggestion was that a private company should be formed. The inhabitants of the Colony, however, appear to have been reluctant to subscribe the money, although the subsequent growth of Hongkong would have made any such investment very profitable.

Finally the Government undertook to provide this essential public service. It was a most fortunate decision. There never have been

Fig. 1.—Hongkong Island. The Pokfulum Reservoir. This was completed in 1871 and for Years was the Only Reservoir for the Water Supply of Hongkong

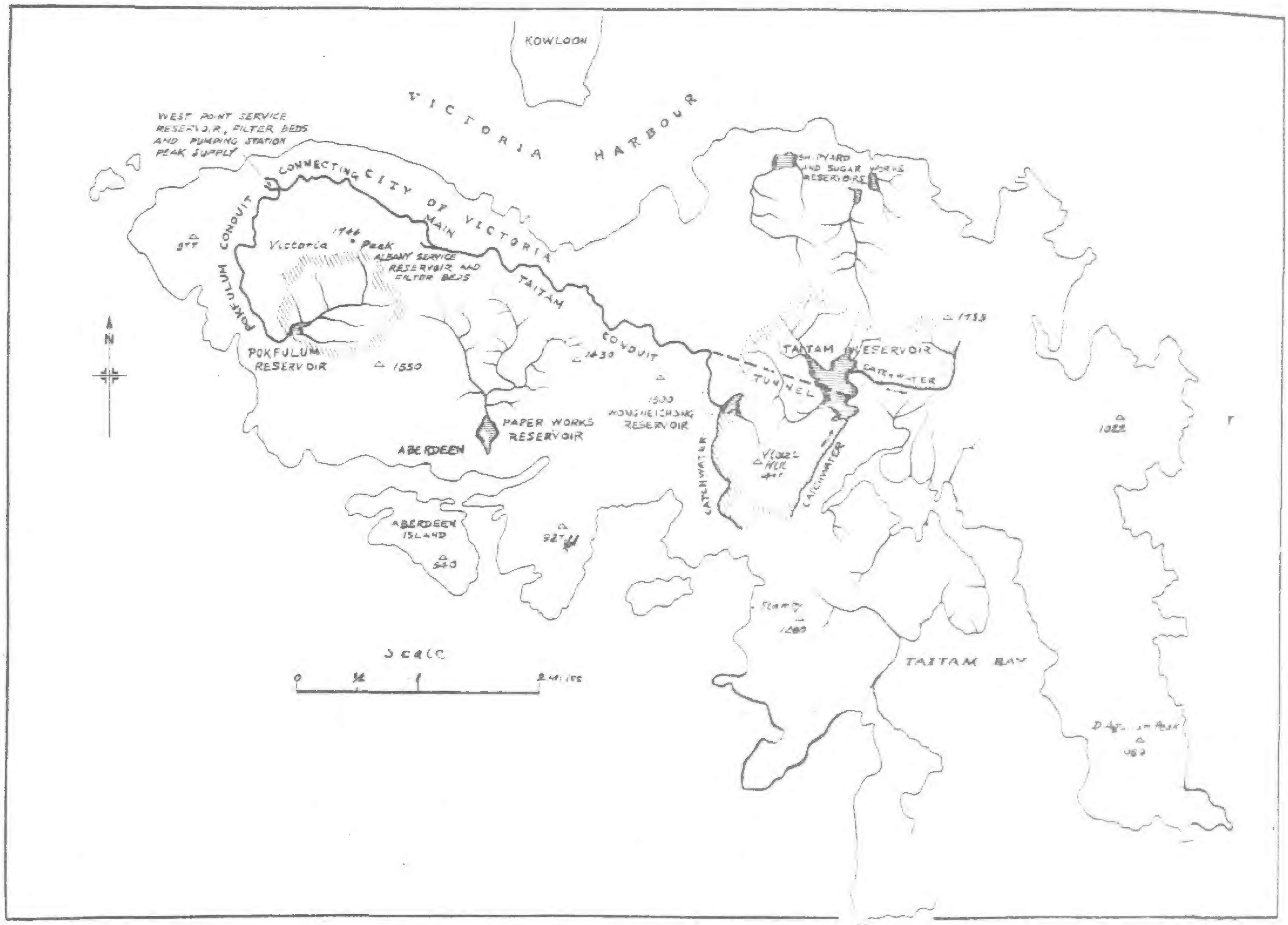


Fig. 2.—Reservoirs and Catchments on Hongkong Island, 1889

vested interests to consider in connection with this public utility in Hongkong. There are those who think that there are now too many vested interests concerned with other public utilities in most large cities. There can be no doubt that it is in the interest of the community that the water supply should be undertaken by a Government, or Municipal authority, if only because of the complexity of the distribution system which affects road excavations.

The First Reservoir

The first reservoir scheme for water supply to be put into operation on the island is that known as the Pokfulan system. The reservoir was built to the West of the island.

It was only a small intake reservoir holding only some 2,000,000 gallons. A ten inch cast-iron main was run a distance of about three miles from Pokfulum to Robinson Road on the North side of the island. There was a tank of capacity 200,000 gallons at the end of the main, and also another tank at the top of Taiping Shan to hold 850,000 gallons. The total cost of this first effort was $170,000.

It would appear that the problem of fire prevention was much in the minds of the local Government Authorities in connection with this first water supply system for Hongkong. The installation included 125 fire cocks and 30 fountains. From that time, onwards, great attention has been paid to water supply for fire prevention.

It must be mentioned that, owing to water shortage, there has, at times, been delay in dealing with fire out-breaks, as the water supply had been cut off during certain hours. It was suggested that delay occurred in the terrible disaster during the annual races at Happy Valley in 1917, when 600 people lost their lives, owing to the sudden conflagration of stands made of matsheds. but that was denied officially. It is however, doubtful whether any water could have been available quickly enough even if the mains had been full.

The Inadequate Supply

As seems so often to have happened in Hongkong, the demand for water quickly exceeded all expectations. No sooner was the original scheme completed than an extension was planned. A much larger reservoir was designed and built (1866-71) at Pokfulum. It was calculated to hold 66 million gallons. The cost of this extension was $223,000. Fig(1) shows this reservoir as seen from the Peak, Hongkong, looking South out on to the sea.

The map, shown in Fig (2) shows the Pokfulam reservoir to the west of the island. It also shows the conduit connecting it to filter beds and distribution centres for the city of Victoria. It shows other reservoirs in existence in 1889. Reference will be made to those other works later.

The figures of cost in the early days seem almost trivial, when compared with the money spent in later years, but it must be remembered that fluctuations in exchange affect the price in silver of imported machinery and piping. Also salaries and wages have greatly increased since the early days.

The next improvement in the system recorded was the replacement of the old ten-inch cast iron main by a conduit three miles long. This conduit still carries water from the Pokfulam reservoir to the city.

In 1873 Mr. Price, the Surveyor General of Hongkong (the title was subsequently changed to Director of Public Works) recommended the formation of a storage reservoir with a capacity of 300 million gallons, in the Tytam Valley ; the scheme was not then proceeded with, but was developed some years later.

There is a record in 1874 of the construction of the Mint Dam and the Blue Pool Dam, on the N.E. end of the island. These works are no longer in use.

Expert Advice

Even with the increase in the storage capacity at Pokfulum there was soon a demand for extensions. Then the grave sanitary

dangers involved by water famine amongst the poorer classes of the Chinese population alarmed the local Government and it was wisely decided to call in the services of an expert in 1882. The whole problem of the water supply for Hongkong was at that time reviewed.

Sir Robert Rawlinson reported in favor of a completely new scheme for obtaining an additional supply from the East end of the Island. Thus there commenced the Tytam scheme which, with many extensions of the original plans, and together with the Pokfulum scheme, supplied all of the water for the island until 1930.

Previous to the construction of the Tytam Water Works the supply to the 100,000 inhabitants in the city of Victoria was (according to J. Orange, M.INST.C.E. of Hongkong) equal to a daily allowance of 5¾ gallons per head. The assumption, to-day, is that an adequate supply is 20 gallons per day per head of population.

The whole of the Tytam Valley water scheme took many years to complete (1883-1917). If we include Wong Nei Chong reservoir it finally provided five reservoirs with a total storage capacity of 2,055 million gallons.

The situation of the Tytam Valley is more or less central draining eastwards. It is surrounded by hills and a large area in the vicinity has always been uninhabited. There is, therefore, in the valley a very large acreage available for catchment. In the early days only a comparatively small proportion of that acreage was drained by catchwaters supplying the reservoirs, but as the demand for water increased, more and longer catchwaters have been built. There are, however, still large areas available as catchment areas. But it is clearly useless to extend them if the reservoir capacity is not sufficient to hold the additional supply thus provided.

The first section of the Tytam works were carried out from 1883-9. The cost was (Hongkong currency) $1,257,000; which was then equivalent to nearly £210,000. This first section, with catchment areas, is shown clearly in Fig (2) at the east end of the island. The furthur extensions are shown later.

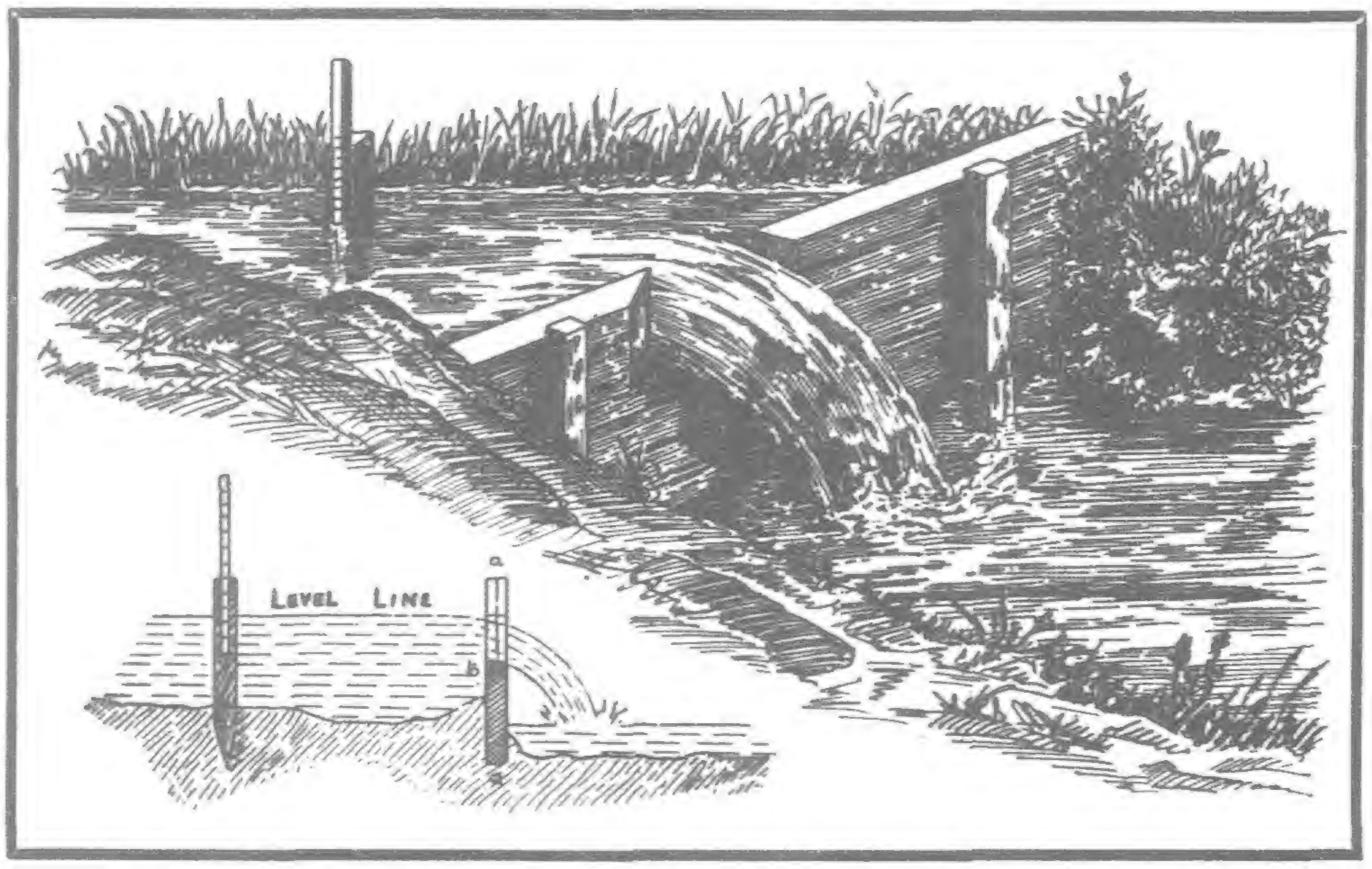


Fig. 3.—A Weir or Notchboard for guaging the quantity of water in a stream

A storage reservoir in the Tytam Valley was made by constructing a concrete dam across the gorge, together with bye-wash, roads, etc. That formed the Tytam reservoir (384.8 million gallons storage to-day). A concrete and masonry dam was built to impound at first 312 million gallons. The dam was subsequently raised.

A conduit tunnel 2,448 yards long was bored through the hills which separated the reservoir from the city. A covered masonry and brick-work conduit 5,302 yards long was also made. This brought the water to the distributing center above the city level. A service reservoir of 5,700,000 gallons, and filters beds, were included in the scheme.

The total cost of this first section of the Tytam water-works was as follows:—

(1) Reservoir	£99,158
(2) Tunnel	£52,950
(3) Conduit	£34,700
(4) Filters and Service reservoir	£22,761
Total ..	£209,579

The Tytam Reservoir is about five miles from the City of Victoria and is situated to the Eastward of the Tytam range of hills. When the scheme was being carried out a steep mountain road, rising 1,000 feet above the sea, had to be traversed to reach the valley. The materials were brought round by sea, landed in the bay, and carried by coolies 1½ miles up the valley by a road with occasional gradients of 1 in 3.

The area of the reservoir is 31 acres; it now holds 384 million gallons, but as originally constructed it held 312 million gallons.

The drainage area of the valley affected was about 700 acres. Careful measurement of the streams at various periods were made by weirs (Fig 3) and data collected. From this information it was calculated that the perennial streams in the valley would yield 200,000 gallons per day.

At the time this scheme was completed James Orange, the engineer in charge of the work, reckoned that a supply of 14 gallons per head per day would be sufficient for Hongkong. He stated (1890) that the volume of water required by Victoria was less than that of an English town, there being in those days practically no water closets in Hongkong. The estimate nowadays is 20 gallons per head per day, for Hongkong. Evidently people use more water as they become more used to a supply system.

The Tytam valley had deep ravine; the hills are mainly rock and disintergrated granite. The heavy rainfall causes a great deal of sand and detritus to be washed from the hills and so filtering is a necessity.

The Tytam Dam

In order to form the Tytam reservoir a dam was built. It was constructed of concrete faced with masonry. The original design was for a masonary dam, but that was abandoned, as it was considered that the cost of European supervision necessary with Chinese masons made it impracticable.

A section of the dam is shown in Fig (4). In its day it was considered a very remarkable piece of engineering work. The section does not show how the water is led away from inside the dam for service, but it shows the scour pipe which is used to remove silt or to completely empty the reservoir.

The total height of the dam, as built, was 120-ft, the greatest depth of water being 100-ft. The dam proper is, 32½-ft. thick at the top and 62½-ft. at the base. An extension of 10-ft., in height, was provided for.

The dam is carried on a concrete foundation block. Cement mortar, two inches thick, covered the rock surface of the base. The dam itself is of rubble concrete, with fine and extra-fine skins. The inner face which is vertical is of ashlar; and the outer face is of rubble masonry and has a batter 3 to 1; the ashlar stone front of it is a facing only.

A Watertight Lining

It is obvious that a dam must be made, as far as is practicable, watertight.

Three different mixtures of concrete, and also ashlar stone, were used in the dam. These are shown in the diagram (Fig 4).

The great mass of this dam, and the foundation block, was made up of granite rubble stones embedded in a matrix of concrete. At first a mixture of 2 parts sand, 1 part Portland cement, and 5 broken stone was used. The broken stone consisted of ¾-in. and 1½-in. cubes in the ratio of 2 to 3. Afterwards, as a result of experience, the concrete was made of 3 parts sand, 1 part cement and 5 parts stones. At 428-ft. above sea level only stones of 1-in. were used and the mixture was 3:1:4; Orange stated that he was "inclined to think 3 parts sand, 5 parts stone, and 1 cement a good proportion with suitable materials." The broken stone was

of hard white granite obtained from boulders on, or not far from, the site.

The face of the dam is of ashlar stone. Between the back of the stones and the rubble mass of the dam there is extra fine concrete, at least 2-ft. thick from the back of the ashlar stones The fine concrete keeps the dam watertight ; great care was taken to puddle it between the two solid walls. It was made of 3 parts sand, 1 cement and 2 broken stone.

Cement from England

Although stone breakers were finally used, most of the stone was broken by hand, as is even now usually the practice in Hongkong for reinforced concrete work. Similarly, although a concrete mixer was after a time used, most of the work was done by hand-mixing.

The stone breakers finally used were worked by a 12 h.p., and the mixer by an 8 h.p., portable engine.

The sand for the concrete was a cause of much trouble and expense. At first there was plenty in the stream bed, but that supply soon gave out and sand had to be carried up by coolies from Tytam Bay, 500-ft. below the level of the dam, and about 1½ miles distant.

The Portland cement, with the exception of a small quantity bought locally, was sent out from England. It arrived in good condition " owing to the excellent mode of packing." Since those days extensive cement works have been built in Hongkong, Canton, French Indo-China, Formosa and Japan. It is needless to add that practically all of the cement now used in Hongkong is made in the Far East.

It should be explained that the overflow from this Tytam Reservoir was so arranged that it does not go over the top of the dam. The situation of the dam site permitted a small valley at one side of the reservoir to be used for the purpose. A small spillway was built for the overflow which ran down to join the main stream of Tytam at a lower level.

Water is drawn off from the reservoir by a valve tower, with valves at different heights. The water drawn off falls by gravity until it is led to the tunnels and conduit carrying it to Victoria. No pumps are needed.

Foundations for the extension of 10-ft at the top of the dam were prepared. The extension was completed in 1897. As there will be an opportunity, in a subsequent issue, to discuss more modern methods of dam construction, no more details of this interesting work commenced in 1883 need be given. But the more closely we examine the matter, the more clearly do we realize the local difficulties that were overcome. And the more do we appreciate the careful supervision given by James Orange, the engineer-in-charge.

Subsequently he left the Hongkong Public Works Department and became a partner in the firm of Leigh and Orange, Architects and Civil Engineers. A close friend of Hongkong's premier financier (1870-1929), the late Sir Paul Chater, he became responsible for a great deal of civil engineering and building construction in connection with the Wharf and Godown Co., the Hongkong and Whampoa Dock Co., etc. Orange died about two years ago.

It is of interest to note that in 1889 there was an acute shortage of water. The population on the island had then increased to 194,482.

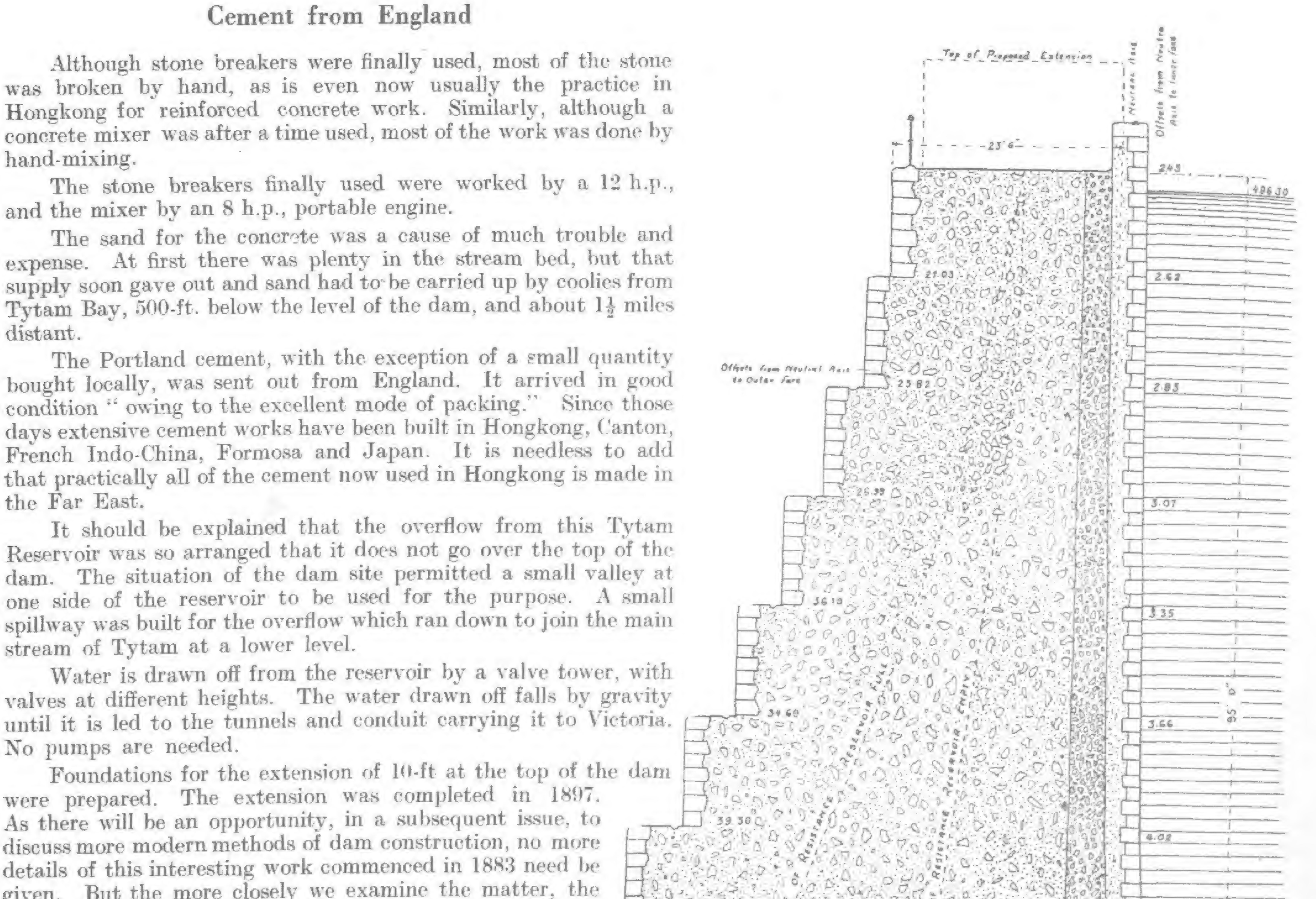


Fig. 4.—A section of the Tytam Dam built in 1883-1889

In 1890 filter beds and a service reservoir of 941,000 gallons were built at a cost of $37,000 at West Point.

Thus, in 1890, the total storage capacity for the Colony had grown to nearly 400 million gallons. It was only three million gallons in 1866. It will be more than 600 million in 1938.

Having greatly increased the storage capacity on the island the next step was to re-organize thoroughly the distribution system.

In 1890-92 three motor pumping stations were built. Twenty miles of mains, varying from 14 inches to three inches in diameter, were laid. Service reservoirs were provided. The cost of these extensions was $160,000.

The Supply on the Peak

It was not until 1891, fifty years after the Colony was founded, that there was instituted a water supply service to the Peak (Fig 5). This water is forced by steam driven pumps against a head of about 1,600-ft. to a small service reservoir on the Peak. The water comes from the Pokfulam conduit, after which it is stored, filtered and pumped.

Fig. 5.—Hongkong Island. Houses on the Peak at Mount Gough

In recent years the demand for water on the Peak has greatly increased. A new pumping station was built to the West of the University in 1914 and new machinery was installed. It is a steam driven station, with long stroke horizontal engines, the pump being coupled direct ; the plungers are in the same line as the pistons of the engines. The pumps increase the pressure in two stages. The normal output is 144,000 gallons air pump per day. Lancashire boilers, with superheaters, supply the steam for the engines.

Fig. 6.—Tytam Intermediate Dam

In 1895 the capacity of the Pokfulum reservoir was increased from 66,000,000 gallons to 70,400,000 gallons. This was only a temporary measure and was effected by placing boards on the top of the dam—an expedient not without danger as any sudden inrush of water to the full reservoir during typhoon rains might carry the boards away and cause much damage by the sudden liberation of a large volume of water.

In 1897 the dam of the Tytam reservoir was raised in heignt by 10-ft. That addition was of masonry and was included in the original design of the dam. It increased the capacity of Tytam from 312 million to 385 million.

Thus we see that in 1897 the total storage capacity (on the island) was 451 million gallons. And thirty-two years later (1929) there was a water famine, although at that date the total storage capacity of reservoirs on the island was a total of 2,118 million gallons.

It was evident, however, before 1897 that more storage must be provided. In 1899 the Wong Nei Chong reservoir was built and that gave another 30,340,000 gallons storage. Even with that addition, Hongkong soon afterwards suffered from a severe water famine.

The next reservoir, in the Tytam Valley scheme, that was created is that known as the Tytam Byewash reservoir, of capacity 22.4 million gallons. This reservoir supplies water by gravity to the conduit. It was a comparatively small addition to the storage in Hongkong, but at the time it was very acceptable. Boards, on the dam, raised the capacity to 26.3 million gallons but proved unsatisfactory and have been abandoned. As its name implies it provides storage for a certain amount of water that overflows, in the rainy season, from Tytam Reservoir. A dam was built at some distance from the spillway bringing the overflow into the small stream. This work was completed in 1904.

In 1907 the Tytam Intermediate reservoir—capacity 195.9 million gallons—was finished. This, as its name implies, is on a lower level than Wong Nei Chong, Tytam and Tytam Byewash, but is higher than Tytam Tuk, the very much bigger reservoir which was finished in 1918. It, however, involved the use of two sets of pumping machinery, each, capable of raising 1¼ million gallons of water a day from it to the level of the tunnel and conduit carrying the supply to the city of Victoria.

The down stream face of the dam holding up water in the Tytam Intermediate Reservoir is shown (Fig 6) at overflow. This dam was built by Mr. Jaffé who afterwards built the Tytam Tuk reservoir lower down stream.

This first section of the Tytam scheme was finished in 1907, the total cost being $896,140. It included the Tytam Intermediate Reservoir, etc., and there were built access roads and 3.3 miles of 18-in. mains were laid.

The Tytam Tuk Scheme

It should be mentioned that in 1896 the Director of Public Works, Mr. F. A. Cooper, proposed, among other works, the

construction of two additional reservoirs, with a joint capacity of 110 million gallons, on sites within the catchment area of Tytam Reservoir, from which a gravity supply was possible.

He alluded to the possibility of two other small reservoirs in the Tytam Valley below, but did not advocate their immediate construction as pumping machinery would be needed.

Commenting on this scheme in 1917, the Director of Public Works, Mr. W. Chatham wrote "The futility of constructing furthur reservoirs within the catchment area of the Tytam Reservoir was however demonstrated in 1901. In that year, the rainfall in what is known as the wet season (May to September inclusive) was the lowest on record, amounting to 39.91 inches, as compared with an average for the previous 17 years of 65.42 inches. The result was that Tytam did not fill."

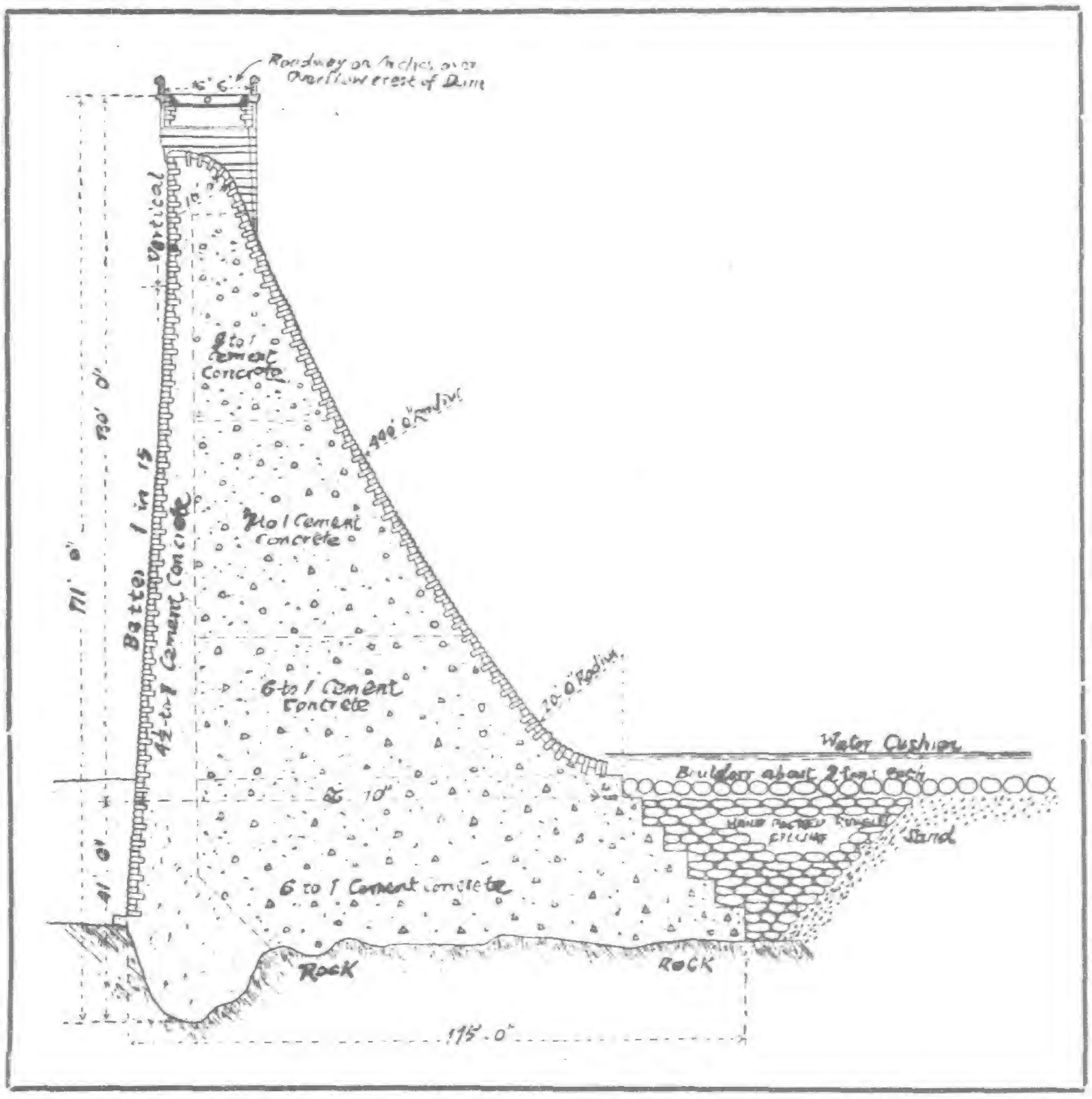


Fig. 7.—Tytam Tuk Dam. Cross section at overflow

Actually the dry season opened in 1901 with about 346 million gallons stored, although the total capacity of all of the three existing reservoirs (Pokfulam, Taitam and Wong Nei Chong) was more than 570 millions.

Mr. Chatham adds that this fact clearly demonstrated "that in providing any additional storage reservoirs, they should be so situated as to derive their supply from additional catchment areas."

In 1902 there was a very serious shortage of water, for in that year water supply was restricted for a period to one hour daily. The reservoirs became so empty that water had to be carried in boats to the island. The worst aspect of the local situation was an epidemic of cholera, attributed to the water shortage. The population was over 300,000 in 1902, as compared with 194,482 in 1889, an increase of some 50 per cent in 13 years.

In 1902 Mr. O. Chadwick visited Hongkong to report, generally, on sanitary conditions. The problem of water supply was referred to him. He advised the full development of the Taitam Valley, with reservoirs and pumping stations.

Steps were taken at once to put up a small dam to intercept the dry weather flow of three principal branch valleys. Temporary pumping plant, capable of raising half-a-million gallons a day, was installed, together with a rising main 1¼ miles long, to the Tytam tunnel.

It was in 1902 that the plans for the two sections of the Tytam Tuk schemes were drawn up.

There was, at that time, no demand for a public water supply on the mainland. The total storage capacity on the island only, was, in 1904 503 million gallons. This was increased, in 1907 to 699,000,000 gallons by the completion of the first part of the Tytam Tuk scheme.

This completes the story of the water supply for Hongkong during the period 1841-1908.

The Recent Work

During the last twenty-six years there has been great activity in the Public Works Department in connection with this matter; since 1908 the extensions and plans for extensions have entirely eclipsed all that was done during those first 67 years. The problem of providing an adequate water supply for Hongkong has been the most prominent topic of public interest during recent years.

The storage capacity of the reservoirs of the Colony was about 700 million gallons in 1908. In 1933 the storage capacity was about 3,100 million gallons. When the works now in hand are completed, in 1938, the total storage capacity of all the reservoirs—open and service—will be rather more than 6,000 million gallons.

In addition to the present storage we may now rely upon a minimum of a million gallons a day in the driest season from the Shing Mun River; and in the dry season for some months, before any crisis arises caused by a drought, that river will be able to supply several million gallons daily.

There are now on the island, three more or less district catchment areas. They are (1) That supplying the (comparatively

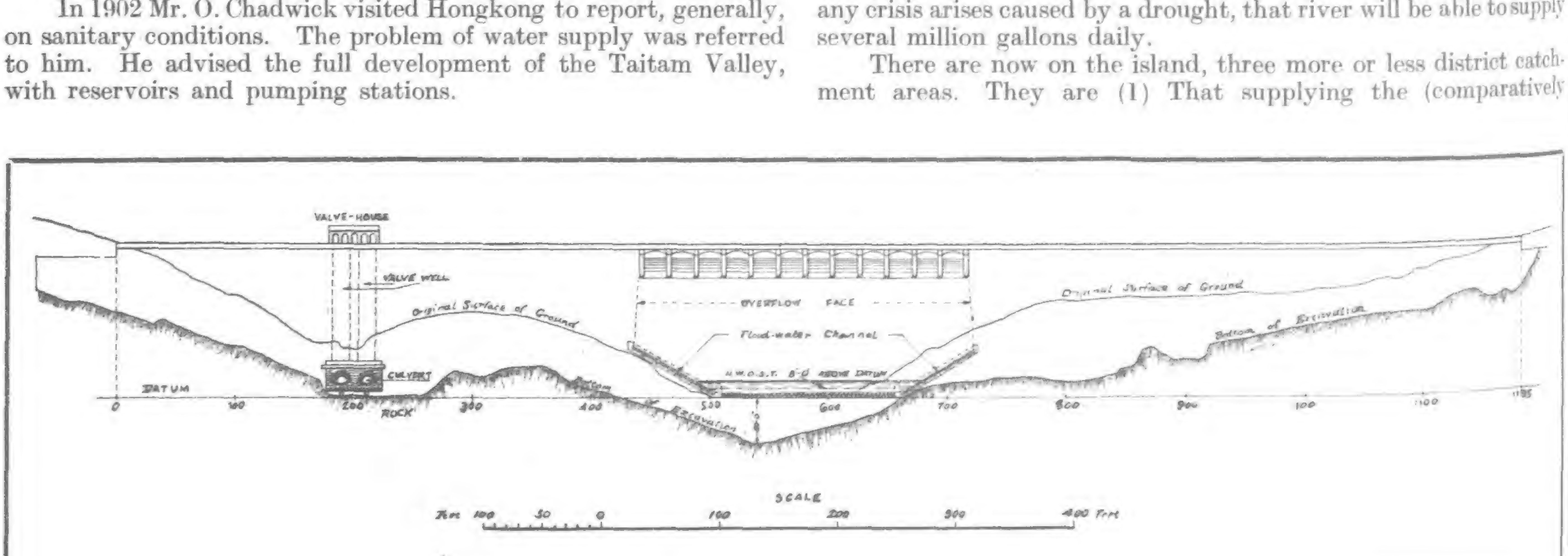


Fig. 8.—The Tytam Tuk Reservoir. Elevation of dam and excavation for foundations

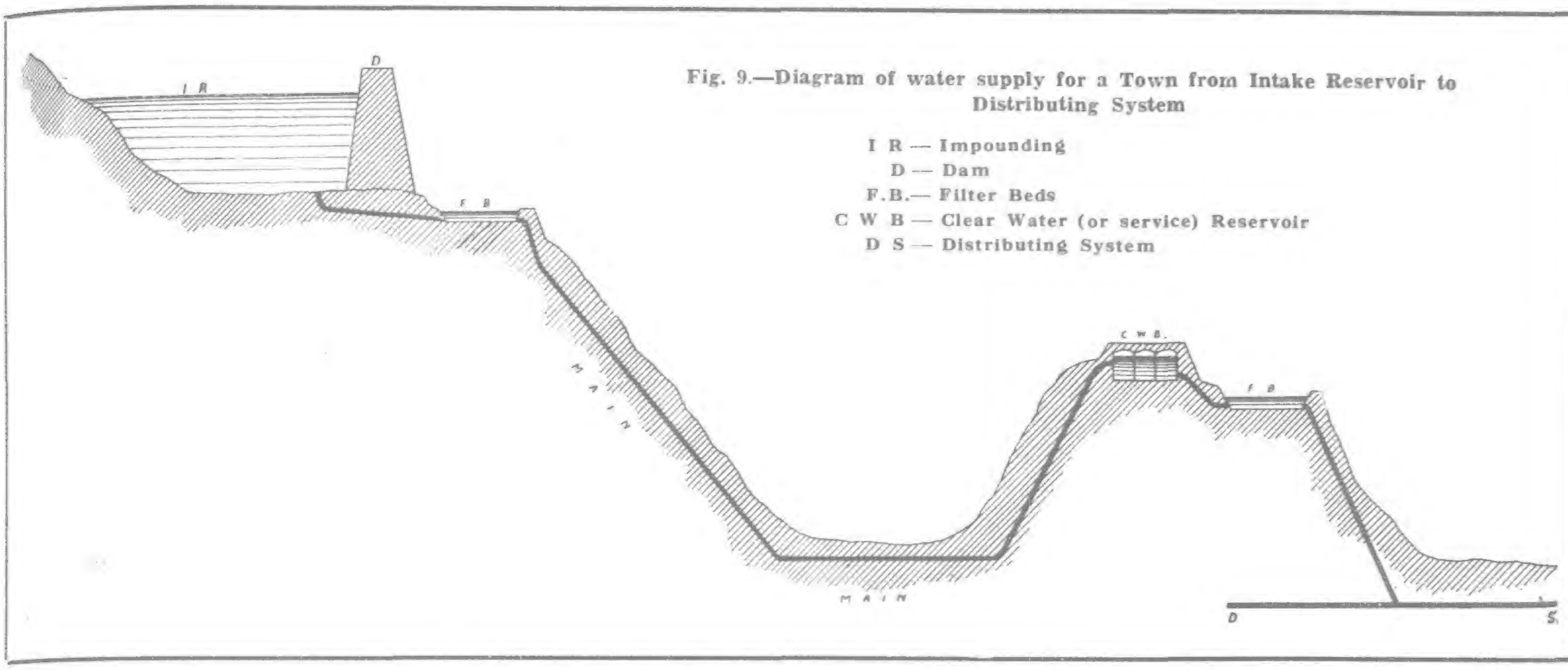


Fig. 9.—Diagram of water supply for a Town from Intake Reservoir to Distributing System

small) Pokfulum reservoir (2) that supplying the series consisting of the group of five of the Tytam reservoirs (including Wong Nei Chong) (3) That supplying the two reservoirs recently built at Aberdeen.

Concerning Pokfulum, some suggestions have been made by residents in Hongkong that this catchment area might be abandoned when the Shing Mun scheme is completed. It contains a large number of most desirable building sites at present unavailable for residences. It is, however, unlikely that the local Water Authority will agree to the proposal; moreover the replacement of the Pokfulum supply would probably cost much more than land sales would produce.

A Big Reservoir

The Tytam section is of great interest to engineers. The five reservoirs are on varying levels. The highest is Wong Nei Chong, the second of the series to be built. It is 730-ft. above sea-level. The lowest is Tytam Tuk, completed in 1917. (Fig. 5 and 8).

To resume the story as from 1908, when the first part of what is known as the Tytam Tuk scheme was completed, we will describe the preliminary work in connection with the second part of the Tytam Tuk scheme.

The proposal was to form a reservoir, as big as possible, by building a dam across an inlet from the sea at the bottom of the Tytam Valley. The first plan included a reservoir of much bigger area than was finally constructed. Practical difficulties, unforeseen at first, made amendments of the original scheme imperative.

It was found, when preliminary borings for the discovery of a good site for the dam were made, that the orginal proposals involved foundations that would be far too expensive to warrant the cost. There are traces yet to be seen of the work done on the site for the dam originally planned. As you pass over the road on the top of Tytam Tuk Dam—the road round the island—you can see, out in the estuary, large blocks of concrete. It is obvious that a dam built along that line would have included for storage a much larger area of the estuary and it would have included in the reservoir the water impounded in another valley. A dam of about 80-ft. in height was projected but if it had been of the same height as the dam that now stands, the capacity of the reservoir as orginally planned would have been almost double that of the one finally formed. Actually the dam originally proposed to be placed on that abandoned site was to be 80-ft. high, much lower than that which was constructed for Tytam Tuk.

However there is still a possibility, in emergency, of building another reservoir adjacent to Tytam Tuk ; but it is not much of a probability because of other developments, which have since 1908, taken place, not only on the island, but also on the mainland. In spite of that there is still a site available for another reservoir on the island, if that becomes an urgent need, and if other plans fail to provide sufficient storage.

The Tytam Tuk Reservoir

However, the most important piece of work on Hongkong island carried out after 1908 was the second part of the Tytam Tuk scheme. And the most difficult part of that was the creation of the Tytam Tuk reservoir. The most costly part of that work was the building of the dam.

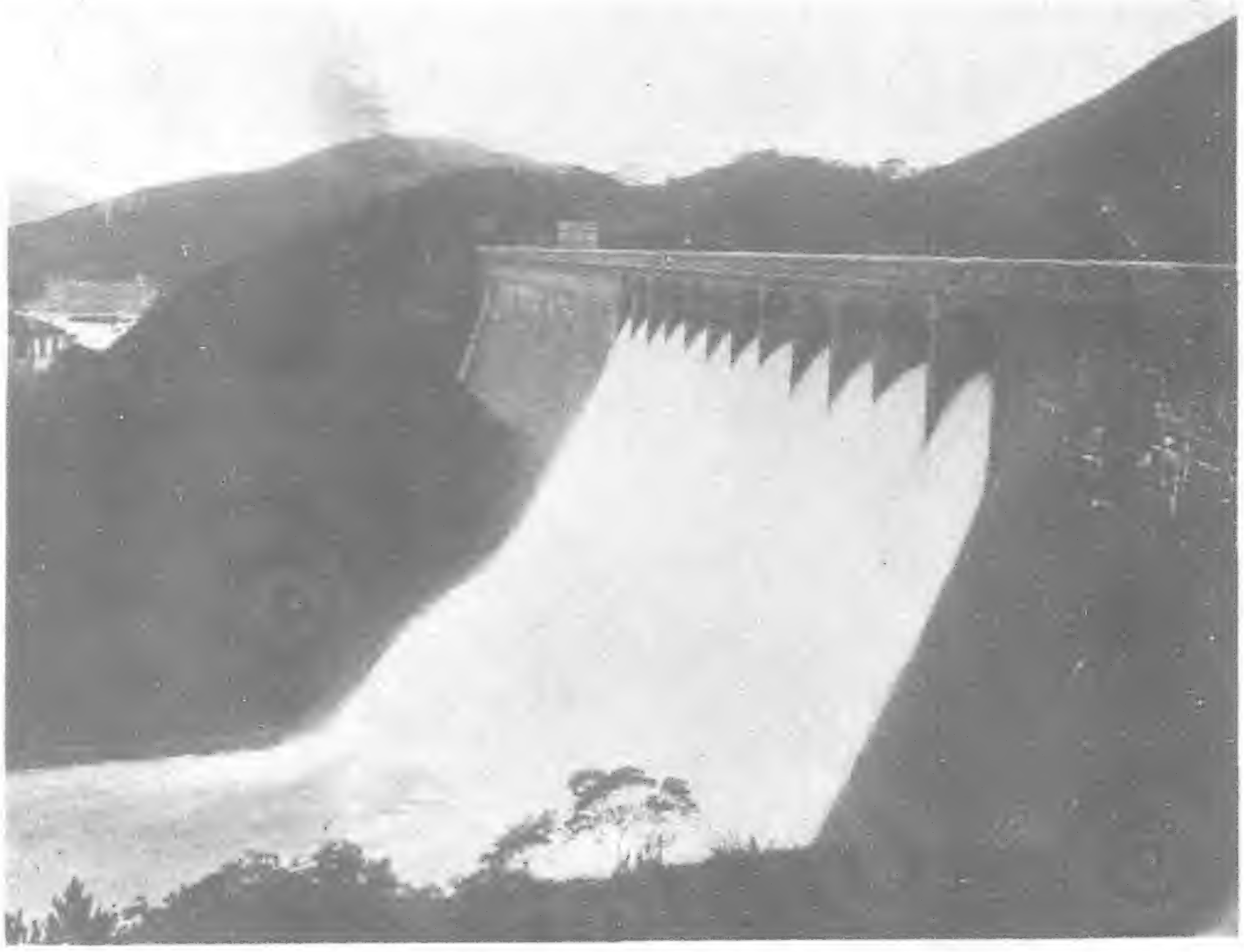


Fig 9A.—Tytam Tuk at overflow

That great structure was commenced in 1912. It will always be associated with the name of Mr. D. Jaffé, M.INST.C.E., the executive engineer in the Hongkong Public Works Department, who not only designed, but supervised, the building of the dam.

A section of the dam is shown at Fig. (7) And in Fig. (8) details are shown giving the original surface of the ground and the general line of excavations.

The district around Tytam Tuk was, in 1912, isolated from the rest of the island. There is now the "round-the-island" road, which passes over the crest of the dam; but in 1912 there was only a foot-path for some miles, connecting the site with a road suitable for wheeled traffic. There was however, the sea-shore near to it and much of the material (such as cement and sand) not available on the site was transported by water.

Jaffé, and other engineers, lived on the site during the construction of the dam. The district had a bad reputation for malaria. And, after the dam was finished, Jaffé, still comparatively young, died a victim of ill-health contracted while building the Tytam Tuk dam.

It has often happened that engineers, on pioneer work in Asia, America, and other parts of the world, have paid with their lives the penalty of a stern sense of duty. There have been few more tragic cases than that recorded of Jaffé. A man of brilliant ability and amazing industry, he seemed destined to reach the highest grade in his profession. But it was not to be.

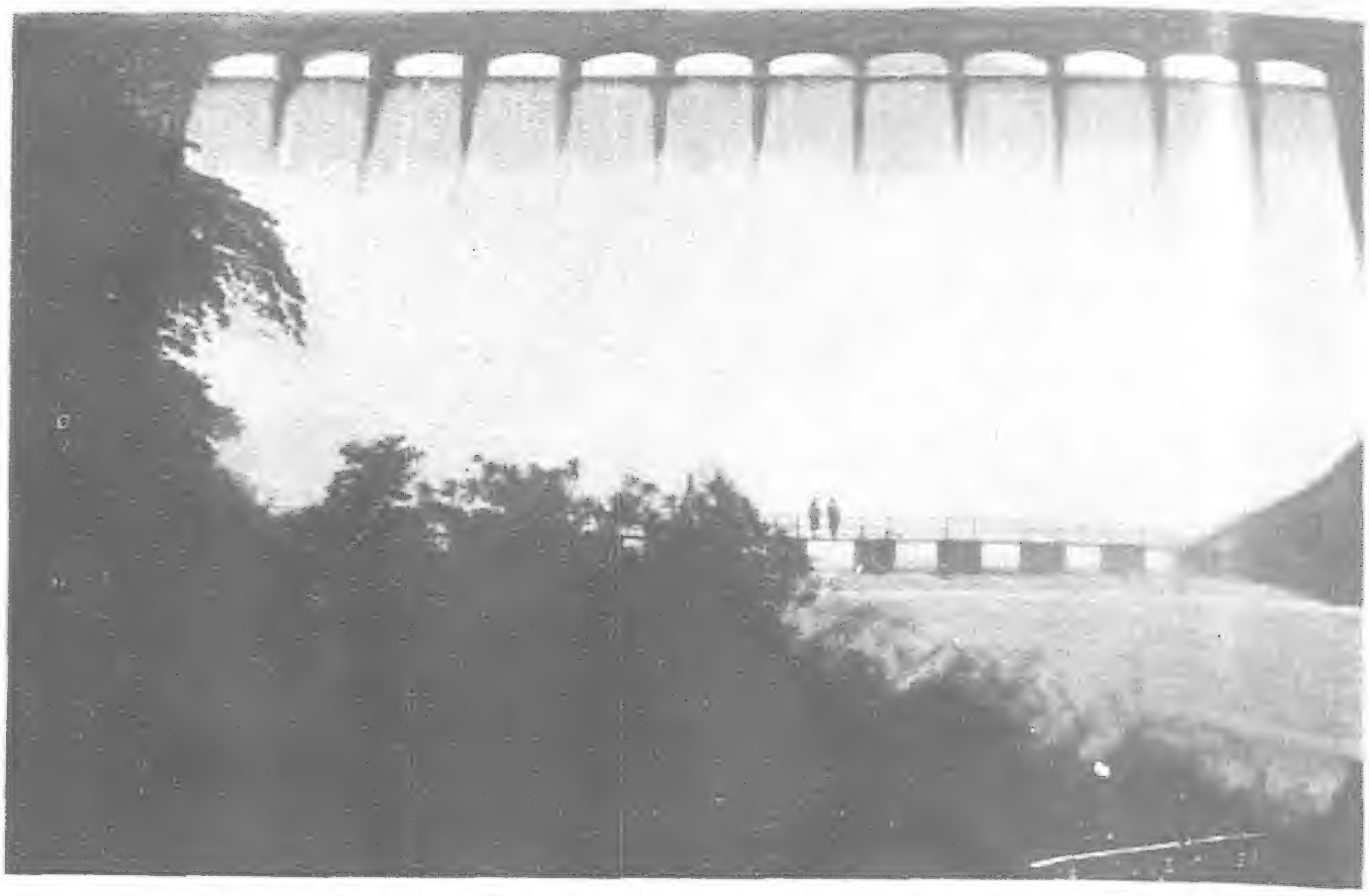


Fig. 10.—Tytam Tuk Dam showing spillways

The Engineer as Hero

Since the official opening of the reservoir, in 1917, it has been my lot to pass the Tytam Tuk dam many hundreds of times, motoring to Shek O and other parts of the island. Always the fate of the capable builder comes back vividly to my mind. During the five years of the construction of the dam, Jaffé often explained to me the details of the work. Every time we met my respect for his ability and devotion to duty increased.

The dam remains for all time a symbol and a monument of the builder. Like the reliable Jaffé there is nothing weak about the magnificent structure that he designed and built. It will survive the shock of conflicting political theories; outlive the struggle of rival religions; witness the decay of the fruits of selfish and cruel ambitions. After the lapse of centuries the dam will still hold up the flood of water that it retains for the convenience and health of many thousands of people.

Unlike the work of many others there is nothing transient about it. For the actions of bad men produce only temporary evil; the actions of good men only temporary good; eventually the good and the evil are mentralised by subsequent generations, absorbed by the constant movement of future ages. But a structure like this immoveable dam remains for all time, for all generations—useful, benficent, a gift to posterity that will never be obliterated. And that, we may be sure, was all that Jaffé asked of life—that his great ability might be spent on something that would be of permanent benefit to his fellows.

Jaffé was one of those almost unknown heroes who have lost their lives in the endeavour to make sure that their work was done thoroughly and efficiently. He was a splendid type of manhood, as well as a clever engineer. And so, as we appreciate the technical details of the building of the dam, and as we see the vast quantity of water it impounds, we may think for a moment of the builder who lost his life in consequence of his work in a then lonely and mosquito ridden corner of the tropics. But we may be consoled by the knowledge that his work will remain as eternal as the Pyramids built in Egypt or any other structure as yet made by man.

Fig. 11.—Viaduct carrying Pumping Mains from Tytam Tuk to Conduit

The Tytam Tuk Dam

The details of this "second section" included other works in addition to the dam. The whole scheme was carried out by the engineers of the local P.W.D., Mr. W. Chatham, C.M.G., M.INST.C.E., being at that time the Director of Public Works. The main items of this "second section" were as follows:—

(a) A storage reservoir at sea-level of capacity 1,420 million gallons.

(b) An extension of the pumping station at Tytam Bay and two additional sets of pumping machinery each to raise 3 million gallons daily from the reservoir to the Tytam tunnel.

(c) About 2½ miles of duplicate mains 18-in. diameter.

The contract for the construction of the dam and contingent works was let to a well known local Chinese contractor in 1912. The total expenditure on this "second section" was about 2½ million dollars (Hongkong currency). Five years were allowed for completion.

It was remarkable to see, in the years 1912-1917, the unusual manner in which the dam was erected, bamboo scaffolding being very much in evidence. It is doubtful whether any other dam of that magnitude ever has been built, or will be again built in the future, in that primitive manner.

During the construction of the Tytam Tuk dam no machinery of any decription was used, not even a concrete mixer. All of the work was done

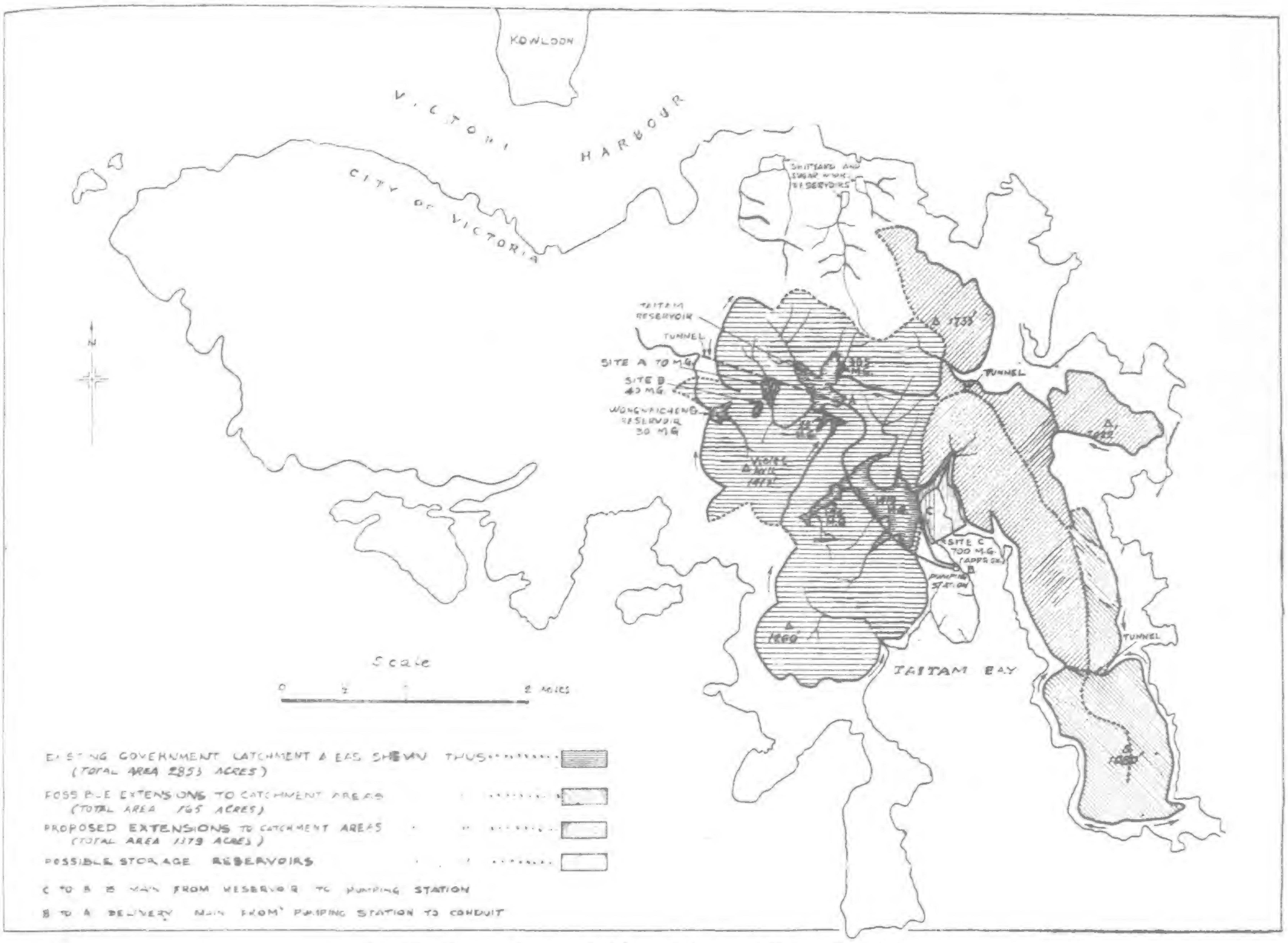


Fig. 12.—Reservoirs and Catchment Areas of Tytam District

by hand and the heavy loads of material were carried by coolies in the then usual fashion in China, with bamboo poles, etc.

In striking contrast is the method of the engineer in charge of the building of the dam in the Shing Mun Valley to-day. For on that work you can see locomotives, compressed air machines, and many other modern appliances used to save time and labour.

The following brief description of Jaffé's structure will give some idea of what was required to make the Tytam Tuk reservoir.

Work on the Dam

The dam is built across the Tytam stream, at the place where it discharges on to the tidal flat at the head of Tytam Bay; it is therefore at sea-level. Its extreme length is 1,255 feet and its extreme height from the deepest part of the foundations to the roadway which surmounts it, is 170 feet; or, to the crest of the overflow, 161 ft. Its maximum thickness at the base is 115-ft. and the maximum depth of water impounded by it is 117-ft.

A special feature of the work is that the foundations in the stream-bed had, for a length of 238 -ft., to be excavated below sea-level, the general level of the sound rock at the deepest part of the foundations being 30-ft. below the stream-bed, or 27-ft. below low-water ordinary spring tides. (Fig. 8) A tongue, varying from 10 to 20 -ft. in width, was cut into the rock to ensure greater water-tightness and was carried down to a maximum depth of 41-ft. below low-water ordinary spring tides. During the building of the dam it was necessary to build two cofferdams, one for the downstream and the other for the upstream, so as to exclude both tidal and flood water.

The dam is of cement concrete, faced on the inner side with granite ashlar and on the outer with granite rubble set and pointed in cement mortar. Except in the case of the backing of the inner facing, for which fine cement concrete ($4\frac{1}{2}$ to 1) varying from 10-ft. 6-in. thick at the base to 3-ft. 8-in. thick at the top, was used, the whole of the cement concrete has granite displacers embedded in it.

The quantities of excavation for the dam and oi cement concrete and granite masonry used in its construction were as follows:—

Soft excavation	62,980 cu. yds.
Rock ,, ...	23,838 ,, ,,
Cement concrete hearting (6 to 1)	31,209 ,, ,,
,, ,, ,, (7 to 1)	39,900 ,, ,,
,, ,, ,, (8 to 1)	28,754 ,, ,,
,, ,, backing of inner facing ($4\frac{1}{2}$ to 1)	28,805 ,, ,,
Lime concrete filling from top-water level to road level	3,338 ,, ,,
Hand-packed rubble filling from topwater level to road level	655 ,, ,,
Ashlar masonry of inner face, except overflow section of outer face	164,858 ,, ft.
Rubble masonry of outer face, except overflow section	59,400 ,, ,,
Ashlar masonry in string courses corbelling courses, parapets, culverts valve-house, etc.	83,361 ,, ,,

It may be mentioned that 246 tons of cast iron pipes, 18 ins. diameter, were used for the additional section and rising mains.

Space will not permit of details of the arrangements for pumping water from the reservoir to the Tytam Tuk tunnel etc., but of course there was a great deal of work done in connection with the erection of machinery, making connections and access roads to the pumping station and to the other reservoirs.

The Completed Work

The island road over the dam has a width of $16\frac{1}{2}$-ft. between the parapets. This is carried on 12 arches over the overflow crest of the dam each arch being 20-ft. span.

The water cushion at the base of the dam extends for a length of 153-ft., and discharges into the old bed of the stream.

The down stream face of the dam is shown in Figs (9) and (10) at overflow.

Water was first impounded in the reservoir in September 1915, 86 million gallons being pumped from it in that year, whilst, in 1916, the quantity pumped was 325 million gallons. On January 1, 1917 the amount of water remaining in the reservoir was 182 million gallons and on May 15, when it reached its lowest level the water in it had been drawn down to the level of the lowest draw-off.

The reservoir was formally declared open by His Excellency the Governor of Hongkong, Sir Henry May, K.C.M.G., in 1917. He took the opportunity to recommend to the people of Hongkong the virtue of pure water for drinking purposes. He expressed, on that occasion, the opinion that there would be no need to worry about water shortage for some years ; in that matter he was a poor prophet, for it soon happened that Hongkong was again short of water. As already mentioned, the total capacity of the reservoir is 1,420 million gallons.

Pumping Arrangements

From all that has been written it will be seen that, although Tytam Tuk is fed by many catchwaters that carry water direct to it, yet it also receives the overflow from the upper Tytam reservoirs.

In recent years many miles of catchwaters have been laid, and many acres of catchment area reserved, so as to increase the sources of supply for Tytam Tuk.

As this reservoir is so near sea level a pumping station is used to raise the water up to a level where it could enter the tunnel carrying the water from the gravity Tytam reservoir into Victoria City.

It must be understood that the water supply of any modern town, or city, involves the construction of an intake reservoir, filter beds, mains to carry water to the filters and mains from the clear water (or service) reservoir to the pipes which distribute the water through the town. Fig (9) is a diagram to show the general principle of this arrangement. From this diagram it will be seen that the feed to the distribution mains is arranged by gravity. It is often necessary to pump from the storage reservoir to the Service Reservoir.

The pumping station at Tytam Tuk is at sea level. It is equipped with slow speed steam engines, directly driving recipcocating pumps. The two biggest engines can lift each three million gallons a day a height of 400 feet.

At first sight it seems strange that electrically driven pumps are not used for the purpose, as they have the obvious advantage of less floor space, less labor charges, etc. But the pumping station was built in 1915, before electricity was available in that part of the island. And electric power was then a much higher tariff than to-day. Having sunk capital in a steam plant, and as coal is sea borne, it was found more economical to extend the station plant than to instal electricial pumps. Fig (11) shows the viaduct for carrying mains from the pumping station. This Viaduct crosses a portion of Tytam Tuk reservoir which was at a low level when the picture was taken.

New Catchment Areas

As Mr. Chatham has explained in his report, it was useless to provide additional reservoirs unless more catchment areas were brought into the supply system and catchwaters were built to drain them.

The whole of the Tytam catchment area is shown on the map (Fig. 12). If this map is compared with that shown in Fig. 2 the large additional catchment area since 1889 will be seen. It must be explained that Fig. 12 shows the areas reserved for catchment to date (1934), as well as the areas proposed for extensions, the areas considered possible (but not very probable) to be used for the purpose of storage reservoirs that may be built in some distant future ; but the successful experience with the harbor pipe line makes it unlikely that these storage extensions will be made unless the supply of water from the mainland to the harbor pipe line fails.

This brings us to the end of the story of the Hongkong water supply on the island until the development of the reservoirs and catchment areas at Aberdeen and the laying of the harbor pipe line. These comparatively new works will be described in the next section dealing with the water supply of Hongkong.

This is the second of a Series of articles on the Hongkong Water supply by Prof C. A. Middleton which will appear on the *Far Eastern Review.*

Hydroelectric Station Flies Into the Wilds of New Guinea

Cows have jumped over the moon and a winged Pegasus has switched his equine tail among the clouds, if one takes song and fable literally, but this is the first time that a hydroelectric generating station has taken to the air and gone places on wings. No song, no fable, no myth, but an actual occurrence.

Four General Electric horizontal waterwheel generators, rated at 875 kv-a. each, together with associated apparatus, left San Francisco on May 1 aboard the S. S. *Carisso* bound for Lae on the coast of New Guinea—an island larger than Texas lying north of Australia and almost touching the equator. At Lae, the equipment will be loaded, one section at a time, into huge all-metal Junkers freight planes and flown 40 miles inland to the headwaters of the Bulolo River, where Bulolo Gold Dredging, Ltd., has established a thriving placer mining camp.

After gold had been discovered in this region in 1925 and the richer veins worked out by prospectors using hand methods and packing their "take" out through the jungle on the backs of natives, it become evident that placer operations on a large scale would pay if the necessary dredges and other machinery could be gotten in.

Transportation, however, was a serious problem—an almost insurmountable obstacle, in fact. The distance involved was not great, but the terrain consisted of dense, nearly impassable, and cannibal-infested jungle, together with a mountain range whose peaks rose to 13,000 feet.

Finally, the pilot of an airplane sent in to investigate the feasibility of using air transport was able to land his ship close to the site of proposed operations. This opened the way and a flying field was subsequently cleared off and levelled to accommodate large, heavily loaded planes.

Then began the slow process of flying in, piece by piece, specially designed mining equipment, including two large dredges. Reducing the size and weight of some parts of the heavier equipment until the planes could handle them presented a nice engineering problem—but the job was done and mining operations, which are proving very successful, commenced. The big Junkers freight planes handle all material going in or coming out—routine shipments or those connected with the further development and expansion of the project.

These ships have a load limit of 7,000 pounds, their hatchways measuring 140 inches by 60 inches with a normal inside height of 70 inches. The cabins, which are 24 feet long and have a minimum height of four feet, will accommodate any long narrow packages up to 24 feet in length which can be threaded through the hatches. All packages, however, must be small enough to leave a one-foot clearance all around.

The four G-E generators rated, as stated above, at 875 kv-a. each, are designed to operate at 11,500-volts, 50-cycles, at 600 r.p.m. The largest single pieces of these machines are their stators, which have a net weight of 6,545 pounds. Boxed for shipment, the stators measure 82 inches by 49 inches by 97 inches. Because of the small margin between their weight and the load limit of the planes, and because of limitations in loading dimensions, it is readily apparent that most of the boxing, if not all of it, must be removed and special skids prepared before the stators can be flown to the mining camp.

The fields for the generators weigh somewhat less than the stators and have more favorable dimensions.

Other apparatus shipped by the International General Electric Company to be associated with the generators in equipping the Bulolo hydroelectric station, include a complete G-E switchboard, a Trumbull power and lighting board, several small G-E lighting transformers, and a 60-cell Exide storage battery. None of these offer a problem for the planes as they can be readily separated into small units of relatively little weight.

The Use of Nickel Alloy Steels in the Automotive Industry*

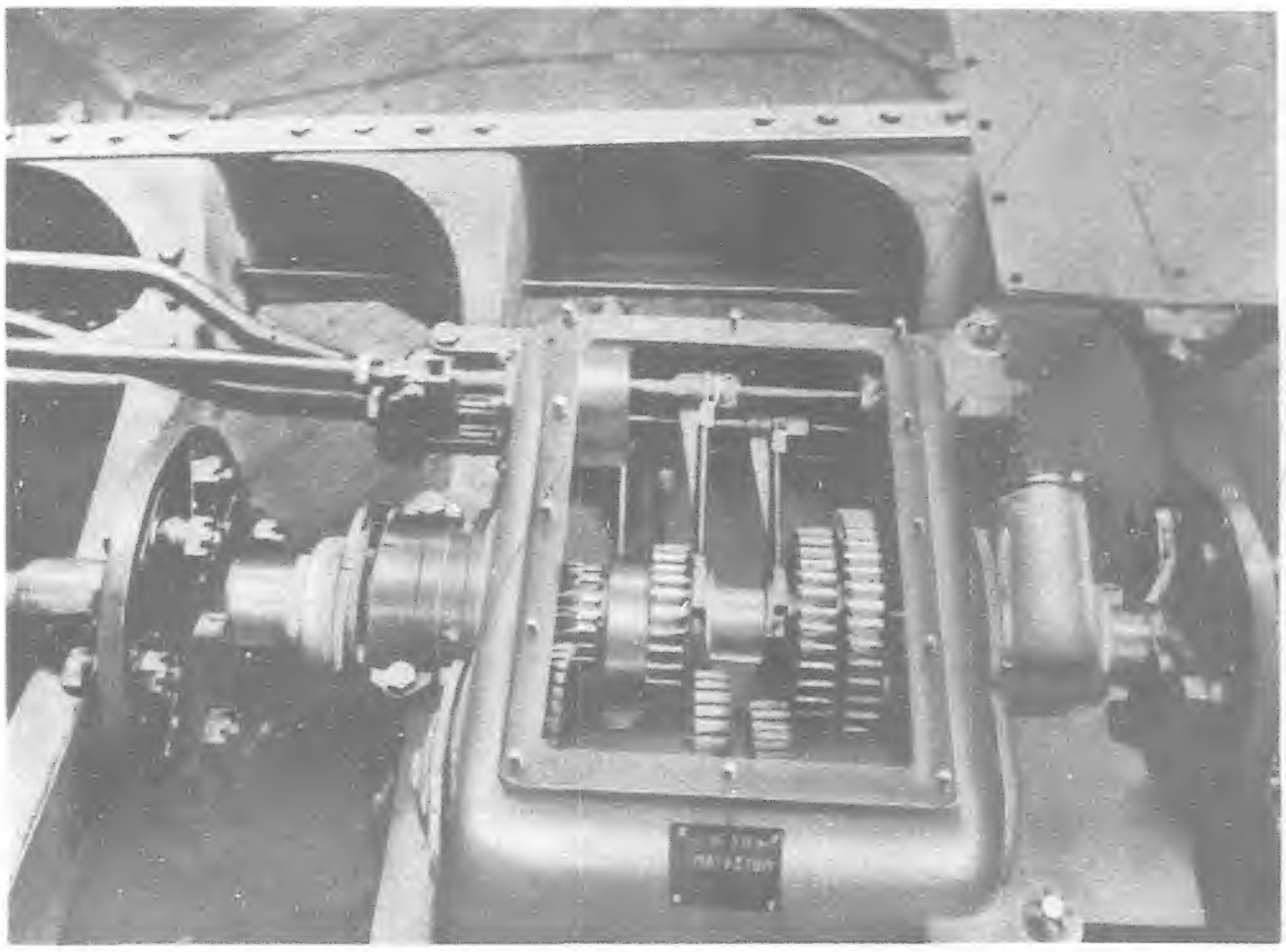


Fig. 86.—Automobile Gear Box with Gears of Nickel-Chromium Case-Hardening Steel. Nickel steels are widely employed for the gears of automobiles in order to provide a combination of wear-resistance, strength and toughness, capable of withstanding extremely punishing conditions in service

Developments and progress in the automotive industry can be followed in the study of design and performance of the winning cars in the annual races, which provide the test in special cars for materials which later become standard in commercial automobiles.

Year by year the size of the motor has been reduced, and the average speed of the winning car has gradually been increased. This constant reduction in the engine size has called for the application of new engineering principles in order to produce greater power and speed.

This has increased the demands on the material used in the individual parts of each unit. For although each part has been made smaller and lighter, it has been called upon to do a greater amount of work than the larger parts were doing in the past. Consequently, the material used has gradually become a major factor in the development of automotive engineering.

The older and larger engines developed their maximum efficiency at about 3,000 r.p.m., while the more recent motors operate at 6,000-6,500 r.p.m.

It is necessary to reach such high speeds that a full charge of gas may be forced into the cylinders during the 1/200th of a second in which the inlet valve is open.

This is done by means of one of several types of a super-charger. The one most generally used is based on the centrifugal blower principle, which operates at a pressure of 1.1 to 1.3 kg/cm^2 above atmosphere. The impeller in the super-charger is driven at about five times the engine speed, or at 35,000 r.p.m. in a racing car. The diameter of the impeller is 216 mm., which gives a peripheral speed of 23-755 m/min. The impeller itself is made of forged duralumin. Gears and shaft driving the impeller are made of five per cent nickel steel.

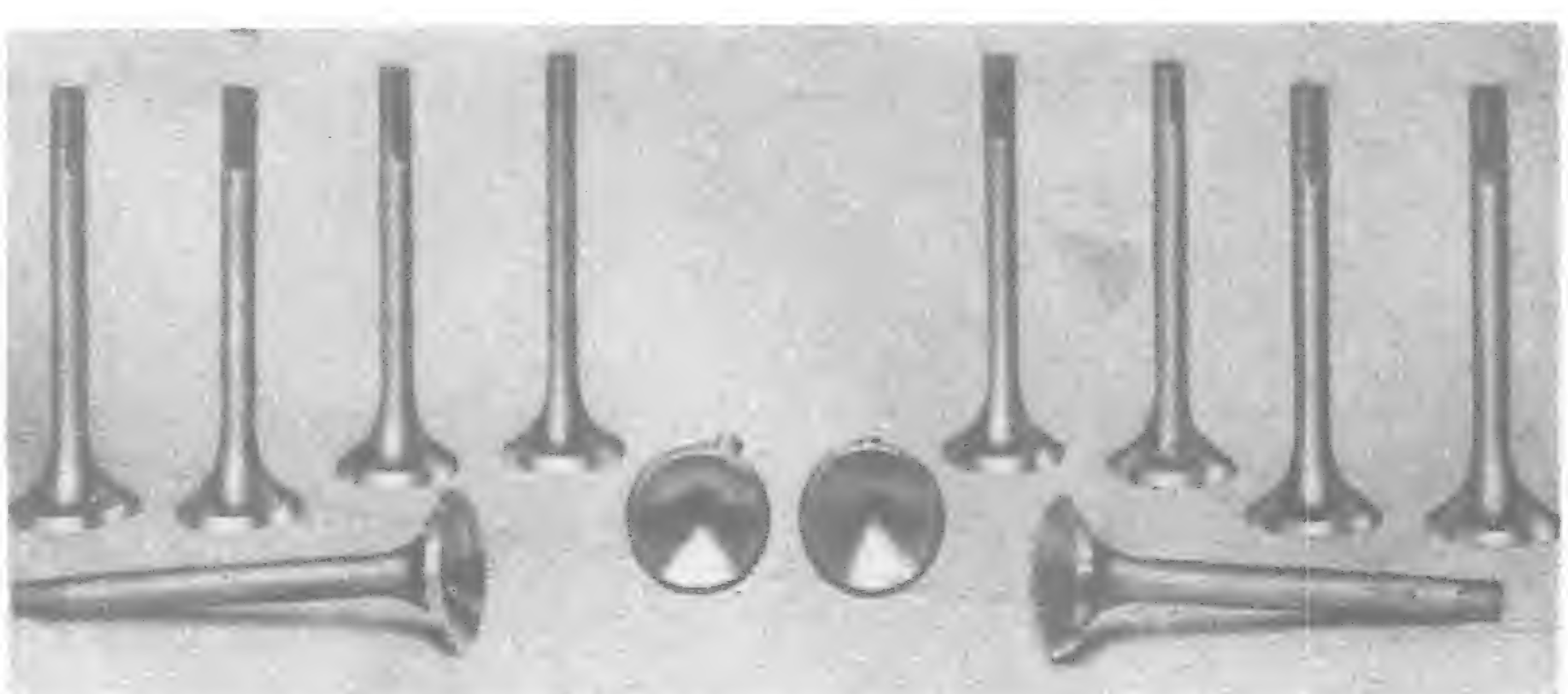


Fig. 85.—Valves of Nickel Chromium Heat Resisting Steel

The designs of an automobile and the selection of steels to be used in its construction are closely related. Design is influenced by the size and weights of the various unit parts, and these parts in turn depend on whether the part is to be made of alloy or carbon steel.

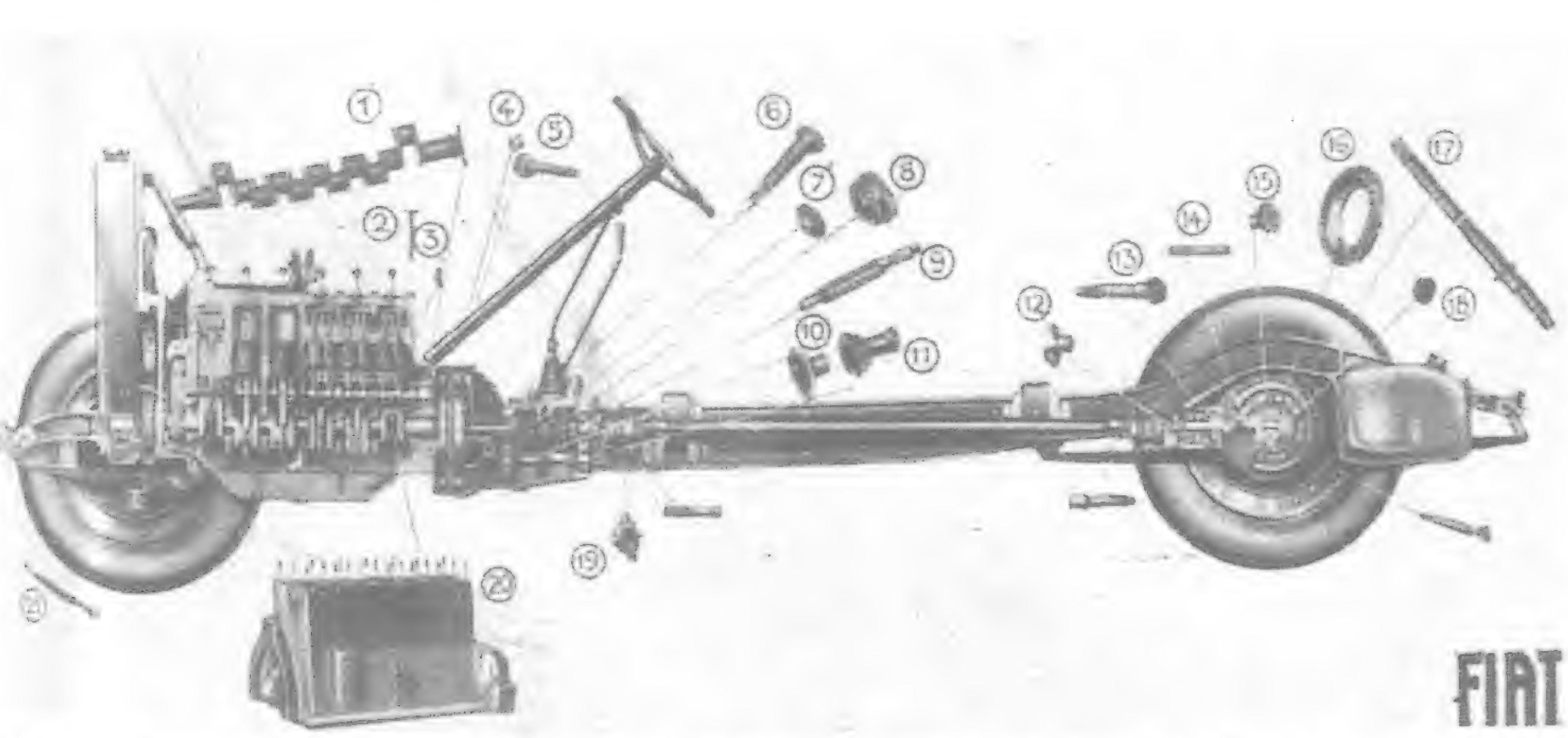


Fig. 87.—Longitudinal Section of "Fiat" (Model 525) showing interior of engine and parts

Metallurgists must meet automotive requirements with materials that will give the minimum cost to the finished assembly. To be on a sound economic basis the steels selected must prove satisfactory both for their lower financial cost and their increased performance. These two factors are by no means always obtained by material that is low in first cost.

Advantages of Nickel Alloy Steels

The greater strength of alloy steel may be utilized to reduce the size and weight of a given part, and with it that of adjacent parts.

Greater uniformity of properties can be secured, resulting in lower rejection of parts in the manufacturing process.

The advantages gained by using the special properties of alloy steel are :—

(1) Wider hardening range.
(2) Improved wearing properties.
(3) Deep hardening.
(4) Higher fatigue properties.
(5) Greater toughness.
(6) Easier machining for a given strength.
(7) More uniform carburizing and hardening.
(8) Less warpage in hardening.
(9) Freedom from grinding cracks.

The full utilization of these properties will result in greater ease of manufacture, and also make possible the use of a new design thus greatly improving the life and performance of the car.

By simplification and standardization, the automobile industry has accomplished the unification of the several types of the special steels.

This does not restrict the number of types nor definitely limit the classification in number and property. The special steels produced are

*Records of the Japan Nickel Information Bureau, Tokyo

placed in one of the following classifications, in which the designation of the steel indicates the composition.

The specifications of the Society of Automotive Engineers give, for some categories of steels, average mechanical characteristics, with their variation in function of treatment in the form of curves, and in addition recommendations as to the manner of using the metal according to the cases.

Therefore, steels are bought according to their analysis. The purchasers' orders merely indicate the designation of the steel required, without giving any specification of mechanical properties.

Nickel steels are essential in every case where it is required to combine a high elastic limit with a high resistance to impact. When nickel alone is not enough, and where, above all, a strong case hardening or a high resistance to wear is demanded, nickel-chromium steels are generally used.

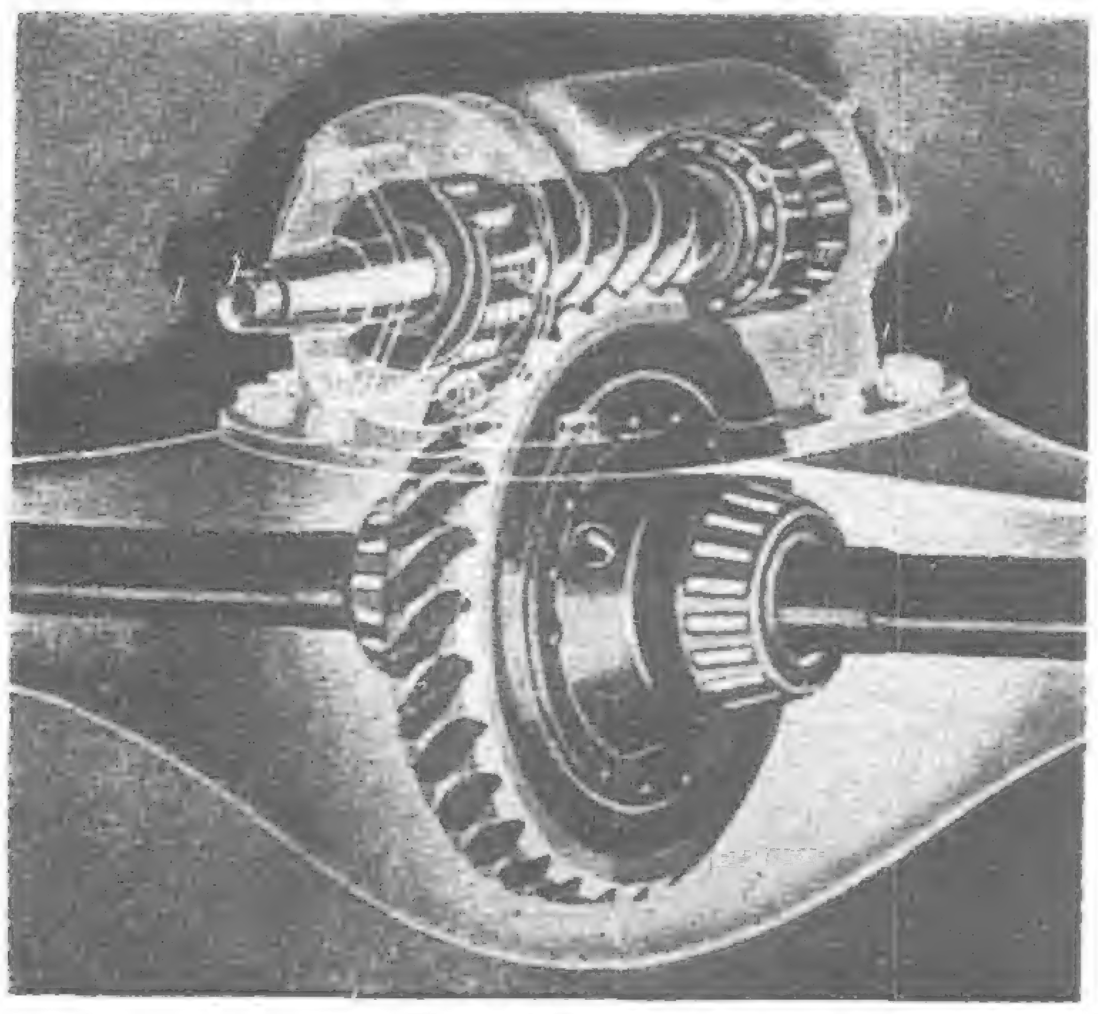


Fig. 91.—Heavy Duty Rear Axle Assembly. Nickel Alloy Steel and Nickel Bronze are used in this assembly

Axles

Nickel-chromium steels are used for the axles, particularly the C=0.35 or 0.40, Ni=1.25, Cr=0.60 per cent combination.

For bus and truck axles, nickel-chromium semi-hard steels (C=0.40) with 1.75 Ni and 1 Cr; or 3.50 Ni and 1.5 Cr; or 3 Ni and 0.75 per cent Cr are employed frequently.

Nickel alloy, steel, S.A.E. 3240 is used for bus, truck and heavy passenger axles.

Extensive tests on various steels have been made. It has consistently been found that the nickel-chromium series is most uniform and dependable, and therefore no change has been made from the original specifications except for the occasional use of nickel-molybdenum steel in special jobs, where it has worked out excellently.

In Table VIII are listed comparative average test results on "Bilt-Well" Ni-Cr Steel axles and another axle shaft of the same size not made of nickel alloy steel (designated as "XYZ"):

TABLE VIII

Make of Shaft	*Tensile Strength* kg/mm^2	*Yield Point* kg/mm^2	*Brinell Hardness*
"Bit-Well" (Ni-Cr).. ..	100	85	286
XYZ (No. Ni)	82	58	241

Fig. 88.—Automobile Axle being Forged

Bolts and Nuts

Steels containing 0.30 C and 3.5 Ni or containing 0.30 C, 1.25 Ni, 0.55 per cent Cr are used for head bolts in connecting rods and flywheels, for bearing fastening studs or cylinder head fastening bolts.

For forked axles, pivots, bolts, etc.,

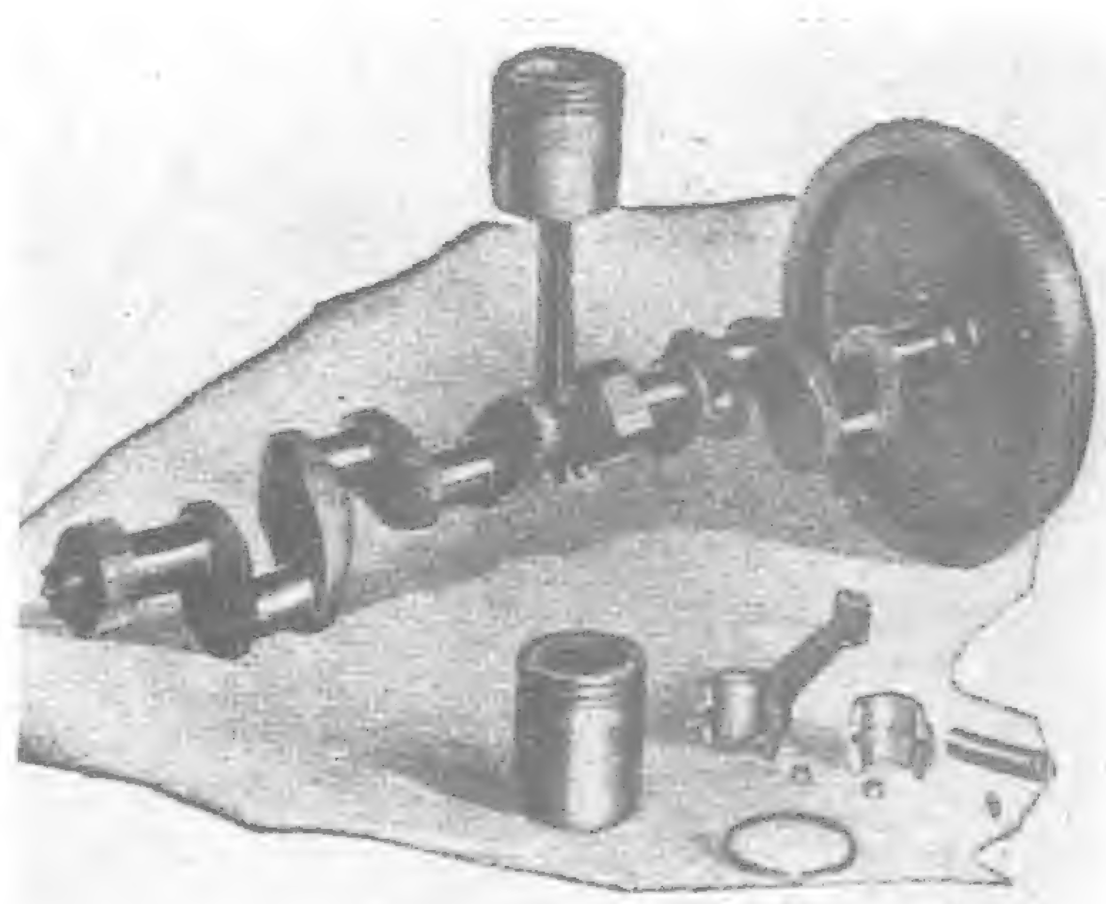


Fig. 92.—Crankshaft Fly Wheel and Piston Assembly. Crankshaft, Connecting Rod and Piston Pin are of Nickel Alloy Steel

the case-hardened steel containing 3.5 per cent nickel is generally used. When further resistance to wear is required, case-hardened steel containing five per cent nickel is used.

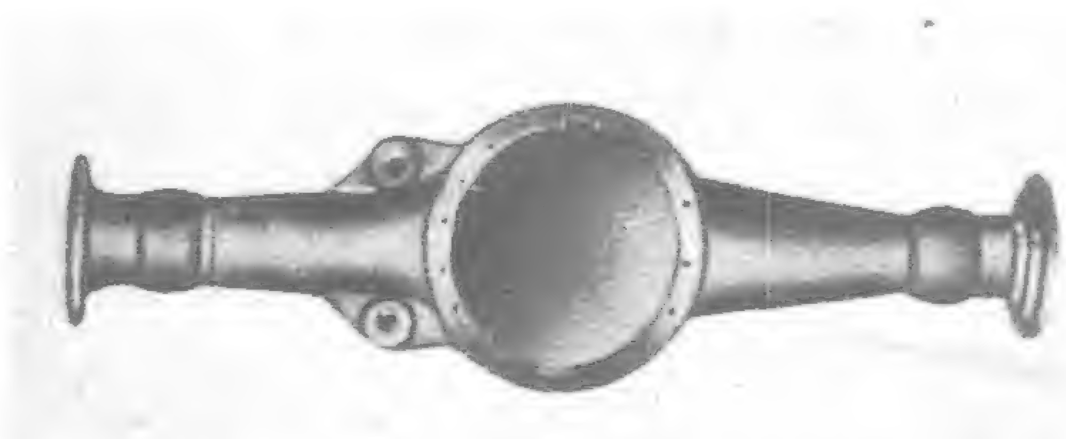


Fig. 95.—Motor Truck Rear Axle Housing, Cast from Electric Furnace Nickel Steel

Case-hardened nickel steels (3.5 per cent Ni) and nickel chromium steels (1.25 per cent Ni and 0.50 per cent Cr) without case-hardening are also used, to a certain extent, for ordinary bolts.

Connecting Rods

Some factories use semi-hard steels with a small nickel-chromium content (1.25 per cent Ni, 0.60 per cent Cr). Duesenberg racing cars are mounted with connecting rods of nickel-chromium-molybdenum steel.

Crankshafts

Many manufacturers of buses and trucks use semi-hard nickel-chromium steels (4.40 per cent C, 1.25 per cent Ni, 0.60 per cent Cr) for crank shafts.

Gears and Gear Boxes

The steels considered suitable for this purpose are S.A.E. steels 2345, 3250 and 3440, that is nickel-chromium semi-hard steel (1.25 to 3.50 Ni with 0.60 to 1.50 per cent Cr).

Some manufacturers case-harden their gears, which are 3.5 per cent or five per cent nickel steel.

Gears and Crowns of Front Axles

All the manufacturers excepting Ford, use special case-hardened steels for the crowns and

Fig. 89—Differential Gear Assembly for Motor Truck. All parts seen are Nickel Alloy Steels

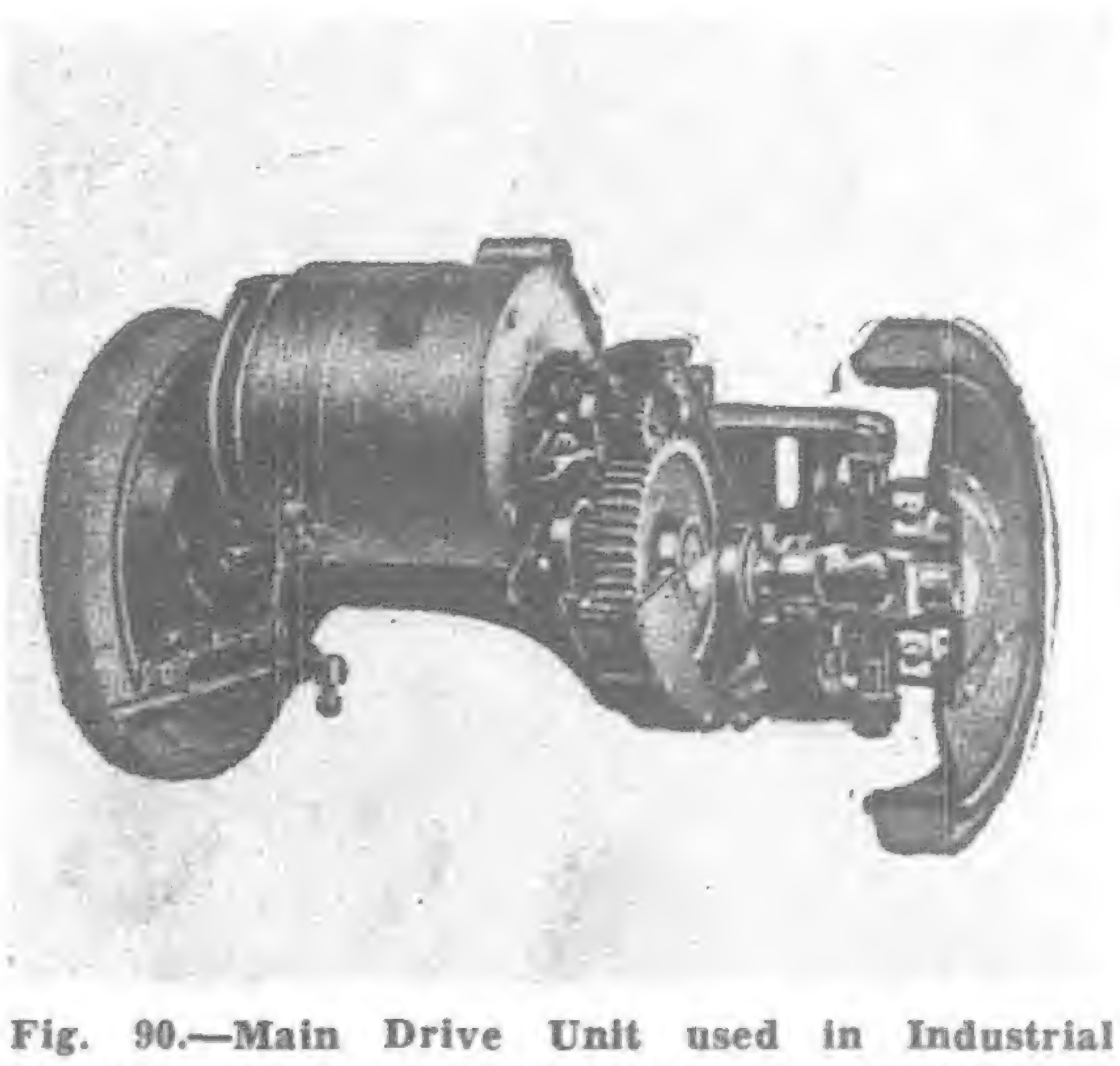


Fig. 90.—Main Drive Unit used in Industrial Trucks. Nickel Alloy Steel is used in Vital Parts

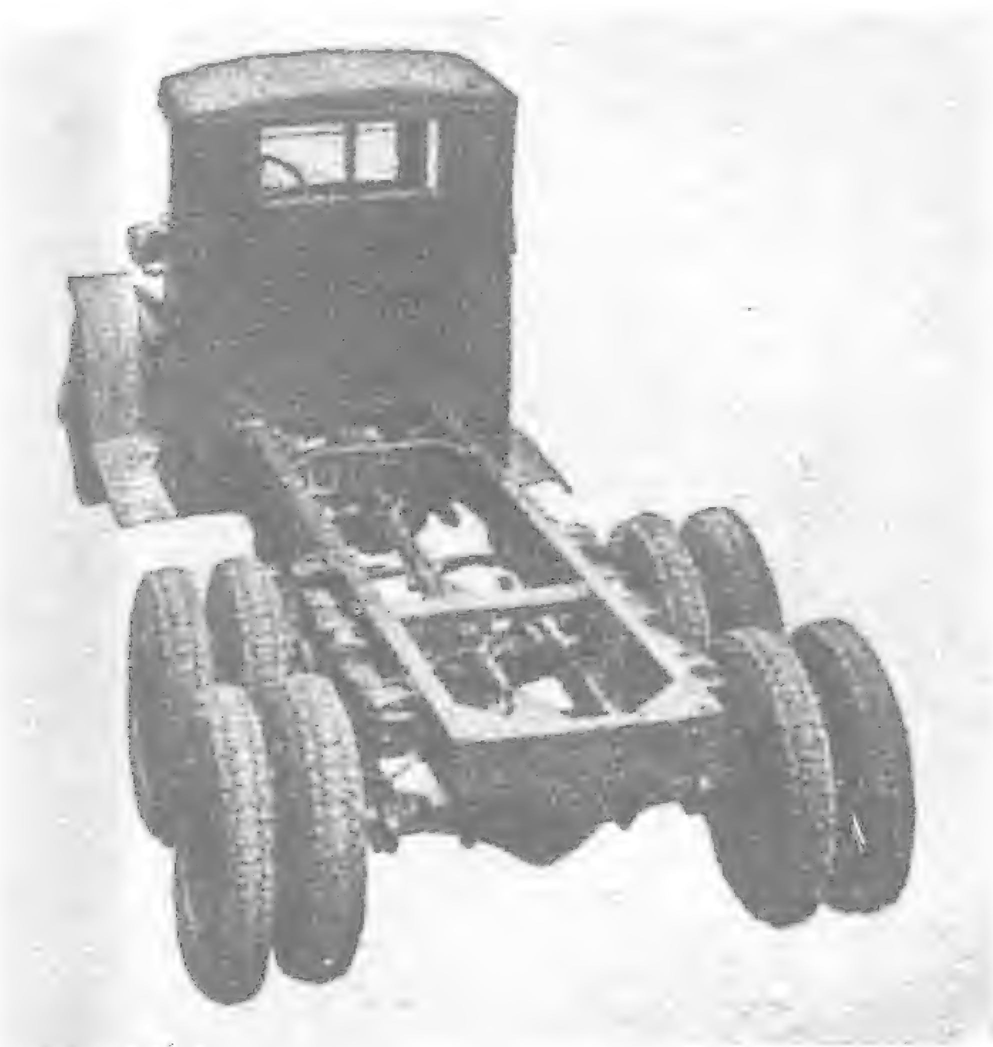


Fig. 98.—Heavy Duty Truck. Nickel Alloy Steel in Transmission, Piston Pins and Valves, Steering Arms, Transmission Gears and Shafts and Rear Axle Shafts

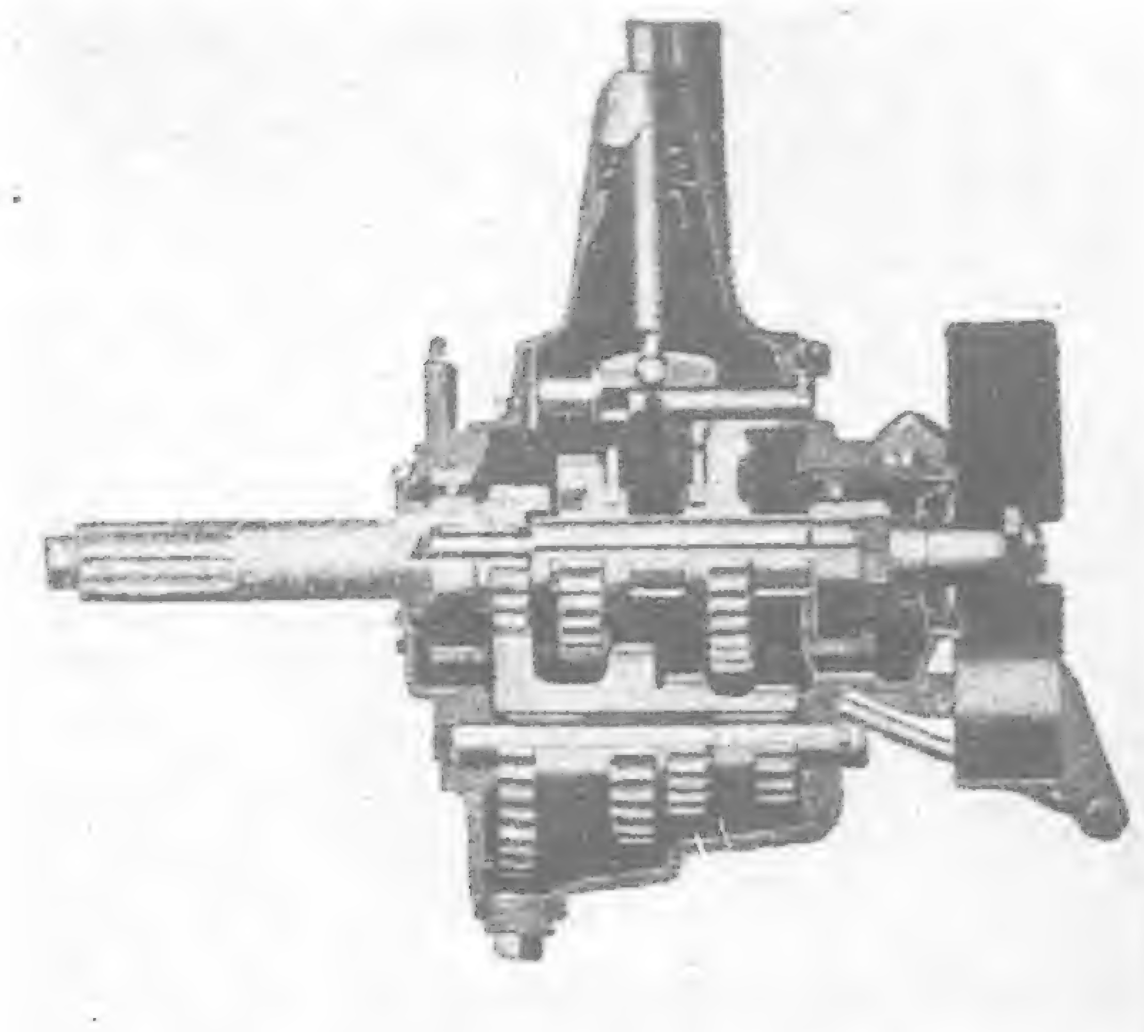


Fig. 99.—Transmission Assembly. All Gears and Shafts shown are Nickel Alloy Steel

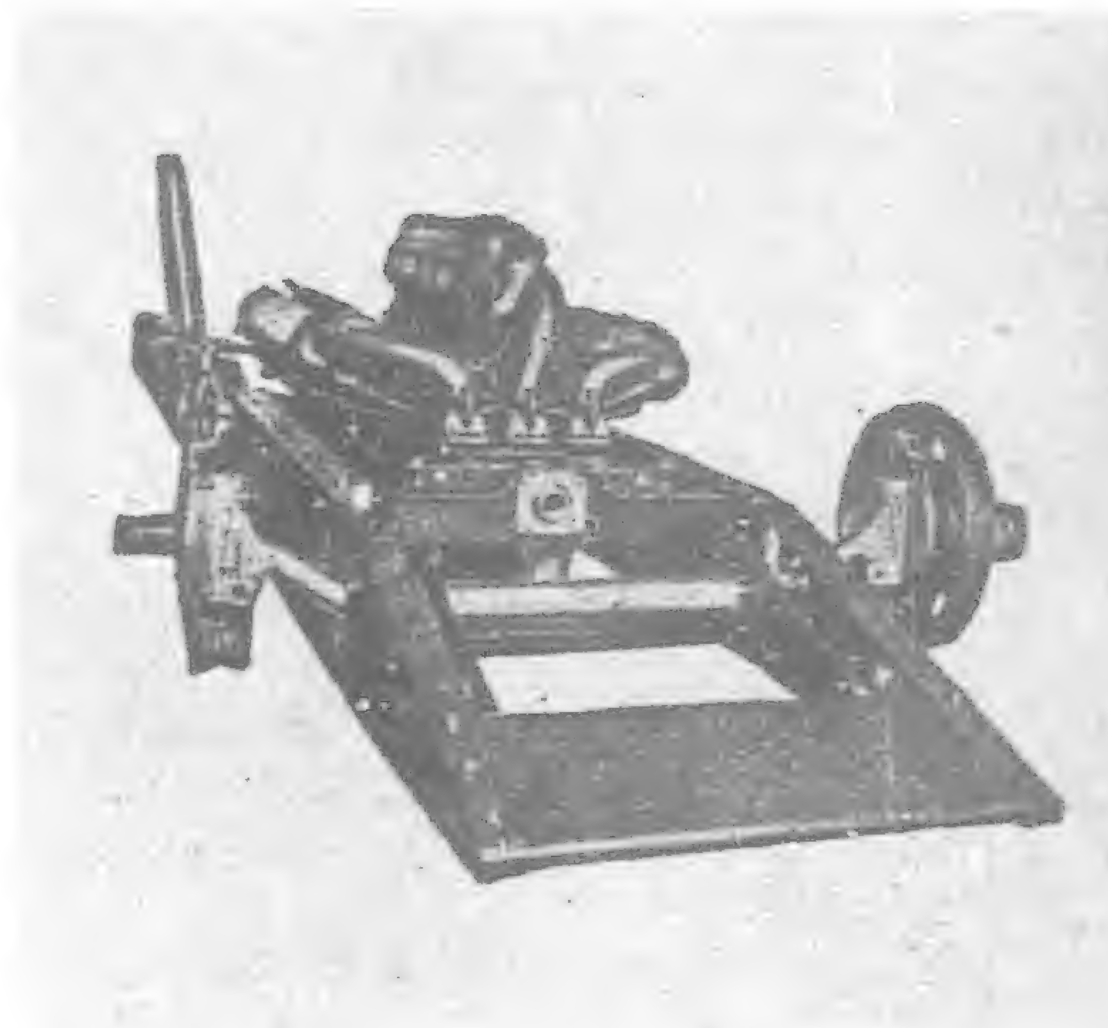


Fig. 100.—Frames and Front Axle of Racing Car. 3.5 per cent Nickel, 5 per cent Nickel and Nickel-Chromium-Molybdenum steels are used in all vital parts

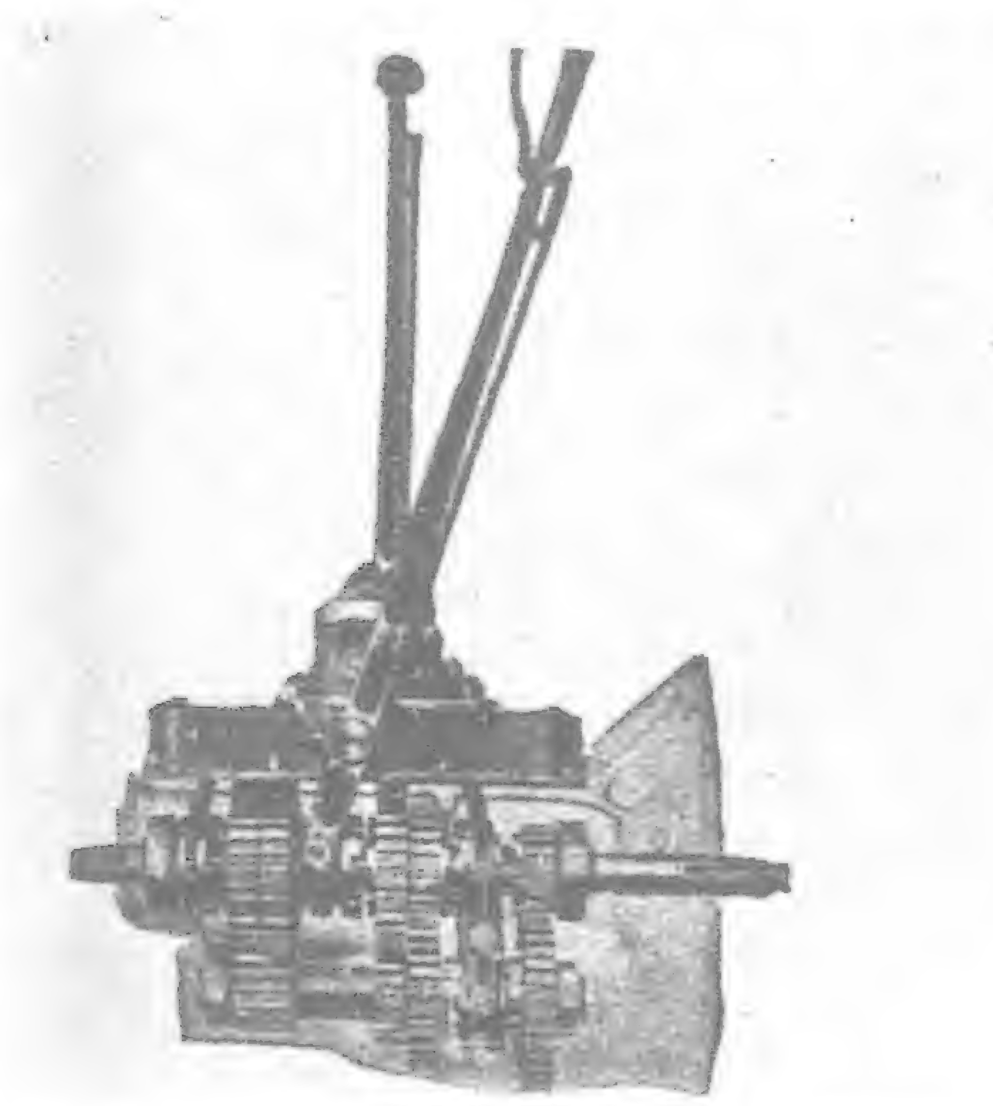


Fig. 94.—Four Speed, Unit Power Plant, Heavy Duty Transmission. Nickel and Nickel-Chromium Steels are used for the Gears and Shafting

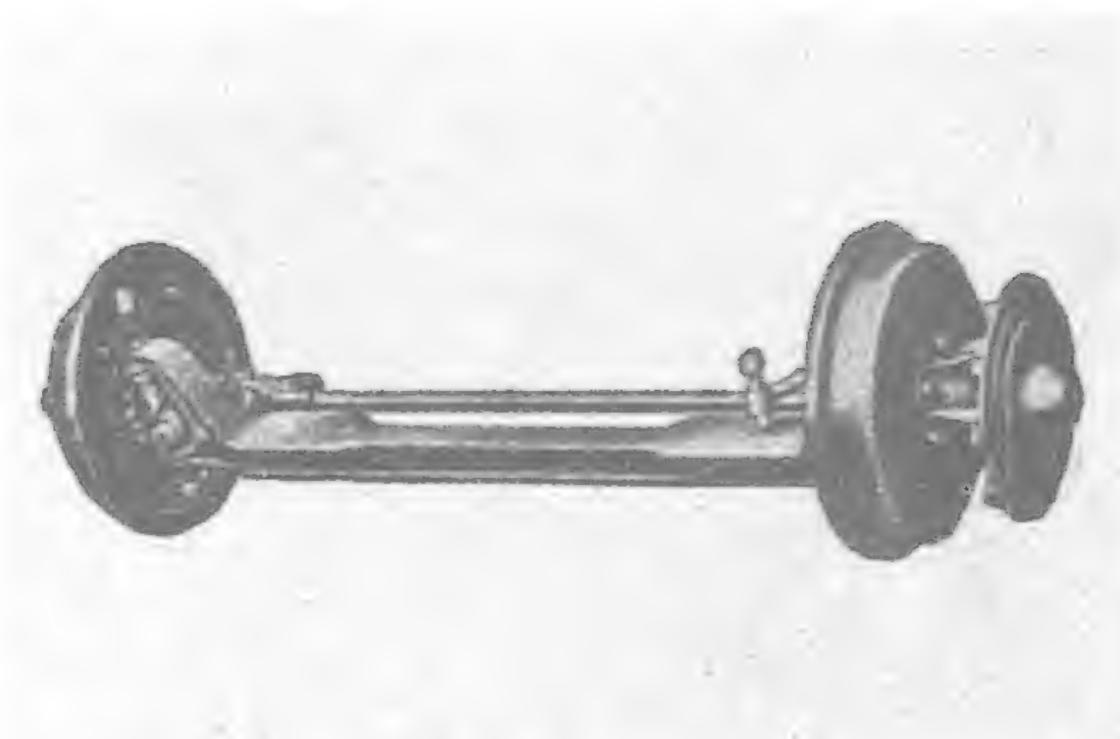


Fig. 93.—Front Axle for 2.5 Ton Truck. Knuckles and Arms are of S.A.E. 3135 Nickel-Chromium Steel, and Pins and Arm Balls of S.A.E. 2315 Nickel Steel

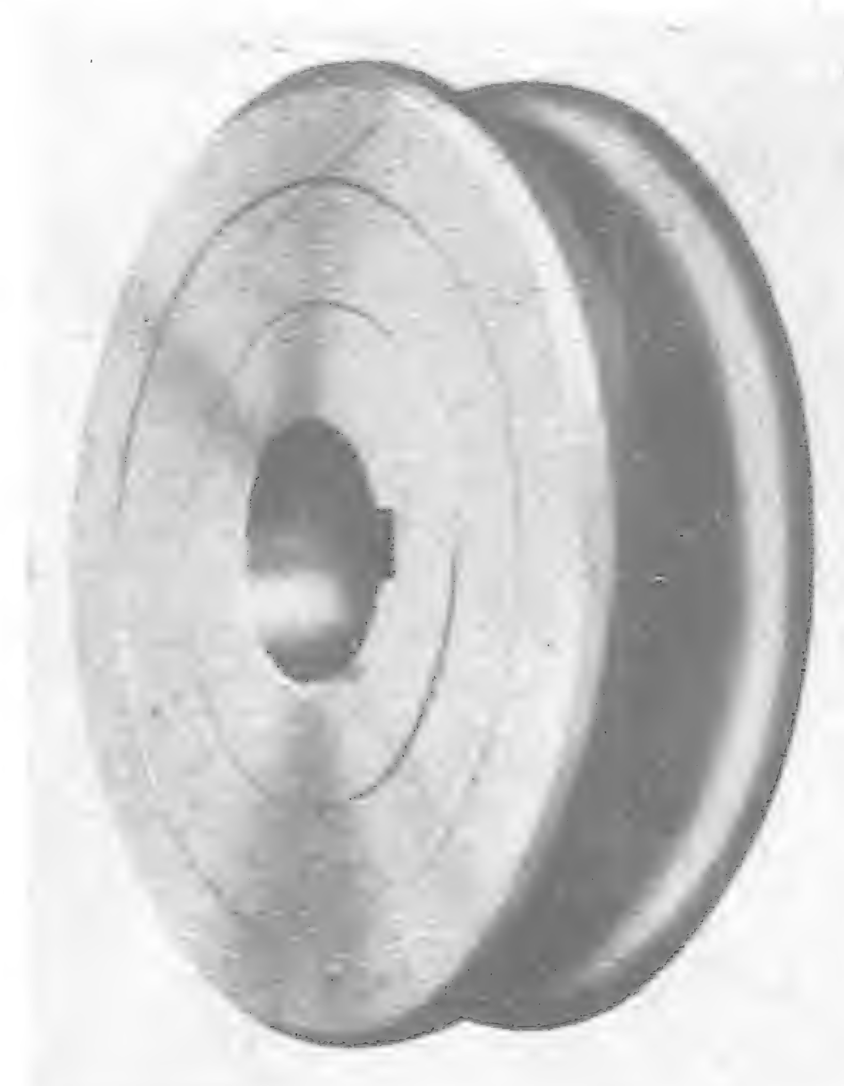


Fig. 97.—Track Wheel used on Rolling Stock. Made from Nickel-Chromium-Molybdenum Steel

gears of front axles and most of these special steels contain nickel. When case-hardened steel or chromium - vanadium steel is used for the crown, 0.5 per cent nickel is added.

The majority of manufacturers use 3.5 per cent nickel steel for the gear and the crown, and the heavy loaded gears are often made of five per cent nickel steel.

For the planetary and satellite pinions, the ordinary steel without nickel or with 0.5 per cent nickel is sometimes used, but, 3.5 per cent nickel steel is generally used.

The gears, which are required to be harder than the crowns, are heated in the cyanide bath before quenching.

Fig. 97.—Intermittent Motion Machinery Clutch. Frame, Cam Gears and Central Gear are of S.A.E. 3250 Nickel-Chromium Steel

Timken Detroit Axle Co. which specializes in the production of front axles for various automobile manufacturing companies, uses a similar case hardened steel (Ni 1.5; Cr 0.45 to 0.75 per cent; V 0.15 per cent; C minimum). This steel is utilized in a carburized and quenched condition. The machining of this steel is easy when it is preceded by a preliminary heat-treatment consisting of quenching and drawing at 675°C to a final Brinell hardness of 156 to 170.

Piston Pins

Piston pins are generally made of case-hardened nickel steels. But nickel-molybdenum steel is also used because of its high hardness.

Valves

Exhaust valves are made chiefly from a silicon-chromium steel (Silchrome) or a tungsten steel. The greater number of companies using these metals, specify steel with a little nickel-chromium or 3.5 per cent nickel steel for the suction valves.

The tremendous development which has taken place in connection

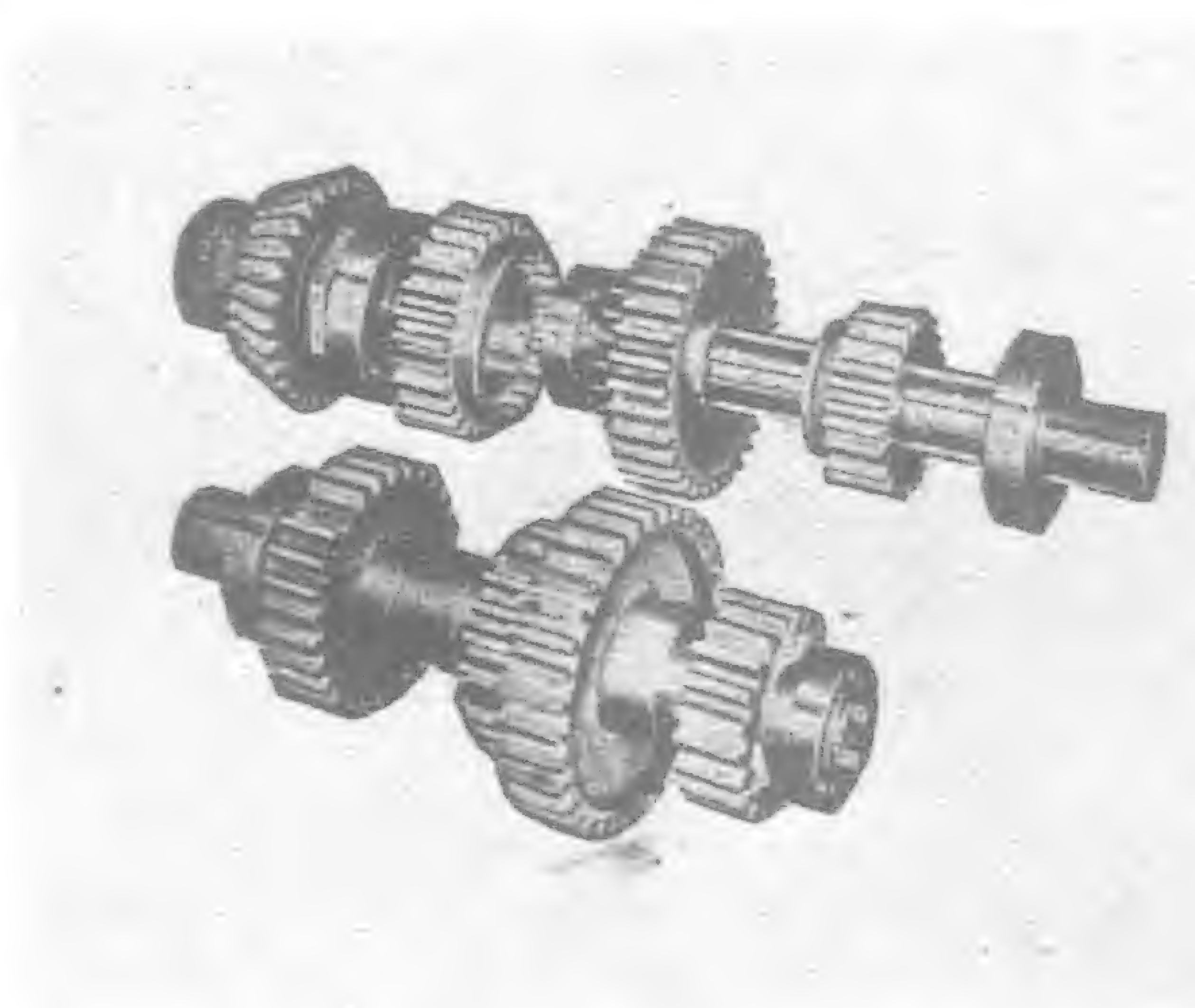


Fig. 100.—Transmission Gears and Shafts. All Gears are of Carburized Nickel Steel

with internal combustion engines has led to much greater engine efficiencies. In many cases this has resulted in high working valve temperature with consequent steadily increasing demand for improved valve steels. The choice of a suitable steel for valves is dependent on many properties, and the following points are enumerated by Dr. L. Aitchison* :

"A valve steel should possess :—

(*a*) The greatest possible strength at high temperatures.
(*b*) The highest possible notched bar value.
(*c*) The capacity of being forged easily.
(*d*) The capacity of being manufactured free from cracks, whether these arise in the manufacture of the steel bar or are produced during the forging of the steel.
(*e*) The capacity of being heat-treated easily, regularly and reliably.
(*f*) The least possible tendency to scale and if scaling does occur, the scale should be as adherent as possible.
(*g*) The ability to retain its original physical properties after frequent heatings to high temperatures followed by cooling to normal temperature, also after being heated to an elevated temperature for a considerable length of time.
(*h*) No liability to harden when cooled in air from the temperature which it will attain when used normally as a valve in an engine.
(*i*) The capacity of being heat-treated after forging so that it is free from strains liable to produce distortion.
(*j*) Sufficient hardness to withstand excessive wear in the stem.
(*k*) The capacity of being hardened at the foot of the stem with considerable ease if necessary.
(*l*) The capacity of being machined easily and satisfactorily by ordinary methods."

High nickel-chromium austenitic steel is admirably suited for exhaust valves. Since it is austenitic, there is no possibility of hardening occurring in cooling down from the high temperature at which the valve may have to function, with the consequent brittleness. The excellent resistance to scaling at high temperatures, associated with high tensile strength and toughness, is also a very valuable property.

Table IX gives the strength at elevated temperatures of this type of steel compared with other valve steels. The superiority is evident at those higher temperatures at which exhaust valves normally function.

TABLE IX.—TENSILE TESTS AT HIGH TEMPERATURES.†

Steel	*Maximum Stress kg/mm²* 600°C	650°C	700°C	750°C	800°C	850°C	900°C	950°C
3% Nickel Chromium	54.0	37.0	21.0	17.5	14.5	11.0	7.0	—
Stainless Steel ..	38.0	27.5	16.0	12.5	9.5	9.0	12.5	—
Silicon Chromium ..	66.0	54.5	40.0	28.0	17.0	11.5	5.5	4.5
Chromium Steel ..	57.5	47.5	30.0	20.5	11.0	11.5	11.5	8.0
Cobalt Chromium ..	71.0	48.0	39.0	21.5	16.0	9.0	12.5	0.5
High Speed Steel ..	64.0	42.0	33.5	26.5	15.0	12.0	13.5	9.0
High Nickel Chromium	67.0	60.0	52.0	45.0	38.0	30.0	24.0	20.0

Valves made from such steels are naturally used in aero-engines, in the high-efficiency engines of motor cars and commercial vehicles, and in Diesel-type engines.

Chassis

Nickel-chromium steel plate of the following composition is frequently used for chassis : C, 0.19 to 0.26 per cent ; Ni, 1.14 to 1.60 per cent ; Cr, 0.40 to 0.60 per cent.

Such chassis of special nickel steels are capable of bearing two or two-and-a-half times the load of the same dimensional chassis of carbon steel.

Some automobile manufacturers use longitudinal bearers in U or I form containing C 0.45 per cent, Ni 3.50 per cent.

Nickel and chromium additions increase the elastic limit, but not the rigidity of the chassis. The rigidity, being dependent on the elastic modulus, varies little from one steel to another, remaining the same, whatever steel may be used in plates of equal thickness. Nickel-chromium steel should be substituted for ordinary steel, when it is desired to increase the strength of the chassis at equal dimensions of longitudinal bearers with sufficient rigidity.

Fabrication of Chains

For the chain links, a semi-hard nickel-chromium steel (0.35 per cent C, 1.25 per cent Ni, 0.60 per cent Cr) is used ; for case-hardened rollers, a steel with the same content of nickel and chromium with at least 0.20 per cent C ; and for the pin a case-hardened 3.50 per cent nickel steel.

A 3.5 per cent nickel steel is used for the pin and links of all models of silent chains. In the transmission chains, semi-hard nickel-chromium steel is used (S.A.E. 3135).

A nickel-chromium steel with 0.15 per cent carbon or a 3.5 per cent nickel steel, oil-quenched after heating in cyanide bath, is used for producing silent chains for automobile manufacturing works.

3.5 per cent nickel steel is also used for the pin of great roller chains applied to trucks and transmission.

Application of Nickel in the Construction of Fiat Automobile

(See Fig. 87)

(1) Albero a gomiti C.N.5‡ (Crankshaft, C.N.5).
(2) Valvole di aspirazione C.N. 5 (Inlet valve, C. N. 5).
(3) Astucci per punterie valvole motore C.N. 5 (Valve guide or push rod tubes, C.N. 5).
(4) Vite perpetua del comando guida N.C.1. cmt. (Steering worm screw, N.C.1. carburized).
(5) Ruote elicoidali del comando guida N.C. 1 cmt. (Steering worm wheel, N.C. 1. carburized).
(6) Albero con ingranaggio per presa diretta N.C. 1 cmt. (Direct drive shaft with pinion, N.C. 1. carburized).
(7) Ingranaggio scorrevole 3*a* e 4*a* velocità N.C. 1. cmt. (Combined third and fourth velocity sliding gear, N.C. 1. carburized).
(8) Ingranaggio scorrevole 1*a* e 2*a* velocità N.C. 1. cmt. (Combined first and second velocity sliging gear, N.C. 1. carburized).
(9) Albero primario per cambio velocità N.C. 1. cmt. (Sliding shaft in gear box or mainshaft to change velocity, N.C. 1. carburized).
(10) Ingranaggio di presa continua N.C. 1. cmt. (Constant mesh pinion or counter shaft gear, N.C. 1. carburized).
(11) Ingranaggio 1*a*, 2*a* e 3*a* velocità N.C. 1. cmt. (The first, second and third velocity gear, N.C. 1. carburized).
(12) Manicotto sul pignione conico per transmissione C.N. 5. (Sleeve for transmission bevel pinion, C.N. 5.)
(13) Pignione conico della transmissione N.C. 1. cmt. (Spider for differential pinion, N. C. 1. carburized).
(14) Porta satelliti per differenziale N.C. 1. cmt. (Spider for differential satelllti pinion, N.C.1 carburized).
(15) Pignione planetario per differenziale N.C. 1. cmt (Differential planetary pinion, N.C. 1.).
(16) Corona conica per differenziale N.C. 1. cmt. (Differential crown wheel or differential bevel ring gear, N.C. 1. carburized).
(17) Albero per differenziale C.N. 5. (Differential shaft or rear axle shaft, C.N. 5.).
(18) Pignione satellite per differenziale N.C. 1 cmt. (Differential spider pinion, N.C. 1. carburized).
(19) Crociera per giunto cardanico N.C. 1. cmt. (Universal joint spider, N.C. 1. carburized).
(20) Blocco cilindri (ghisa per cilindri al nickel cromo). (Cylinder block, cast for cylinders, containing nickel and chromium).
(21) Perno a chiave per freno route anteriori N.C. 1. cmt. (Front brake cam with shaft, N.C. 1. carburized).

Air-Cooled Engines

Economy of fuel is gained through air-cooling and super-charging, the twelve cylinders of the Franklin car using no more gas than an ordinary eight. The dependability of such an air-cooled engine is suggested by the list of parts which are made from nickel alloy steels :

Steering knucle arms ..	.. S.A.E. 2335
Steering pin and bolt stud..	.. S.A.E. 2315

(Continued on page 376)

*Proceedings, Inst. Auto. Engineers, November, 1919.

†P.B. Henshaw—"Valve Steels" Jnl. Roy. Aero. Soc., Marc1972.h, Vol XXXI, No. 195, pp. 187—217

‡N. C. 1. is Fiat's special sign for the steel containing Ni 2-3 per cent, Cr 0.6-0.8 per cent, and C 0.14-0.17 per cent ; C.N. B for that containing Ni 2-3 per cent, Cr 6-8 per cent and C 0.35-0.40 per cent.

Sisalkraft's Uses in Engineering, Construction, Agricultural and Industrial Fields

A new protective paper of innumerable uses has been developed by combining the waterproof qualities of asphaltum, the non-elastic strength of Java sisal fibres and the toughness of kraft paper. The product is known as Sisalkraft and as shown in the cross sectional sketch consists of vertical and horizontal layers of sisal fibres evenly spaced and entirely embedded in asphaltum between covers of heavy kraft paper, the six layers incorporated in a homogeneous sheet by heat and pressure.

The result is a material offering very definite advantages over other types of building paper—imperviousness to air and moisture; resistance to damage by fast or careless application, also to wind ripping during the course of construction; flexibility which permits bending around angles and into openings throughout curing; ease of applying and the saving of labour costs.

Fig. 1.—Sisalkraft made this a harder, denser, longer lasting concrete job, less subject to scuffing. Note the shine, showing flint-like hardness after ten days of curing

Concrete Pavements and Floors

One of the most important recent uses developed for Sisalkraft is the automatic curing of concrete. This use started originally in large office buildings, factories, garages and warehouses. Concrete engineers then experimented in curing concrete roadways with very happy results. The principle involved is that Sisalkraft, covering the concrete slab as soon as it has set, affords a waterproof blanket which retards the evaporation of moisture from the slab and makes possible a uniform and complete curing of the entire mass. For outdoor work this new method does away entirely with the use of wetted down sawdust, sand, straw or burlaps. In indoor construction the protective value of this method is of high consequence for the covering keeps off all debris which might mar the surface and yet permits walking and working on these surfaces long before the cure is completed. The factor of economy is that Sisalkraft may be used from five to ten times in protective work of this nature. American engineering practice has been to cover outside concrete with proper widths of Sisalkraft, lapping the edges four to six

Fig. 2.—Sisalkraft over sheathing. Bends to go around corners without breaking. One man handles and applies in any weather

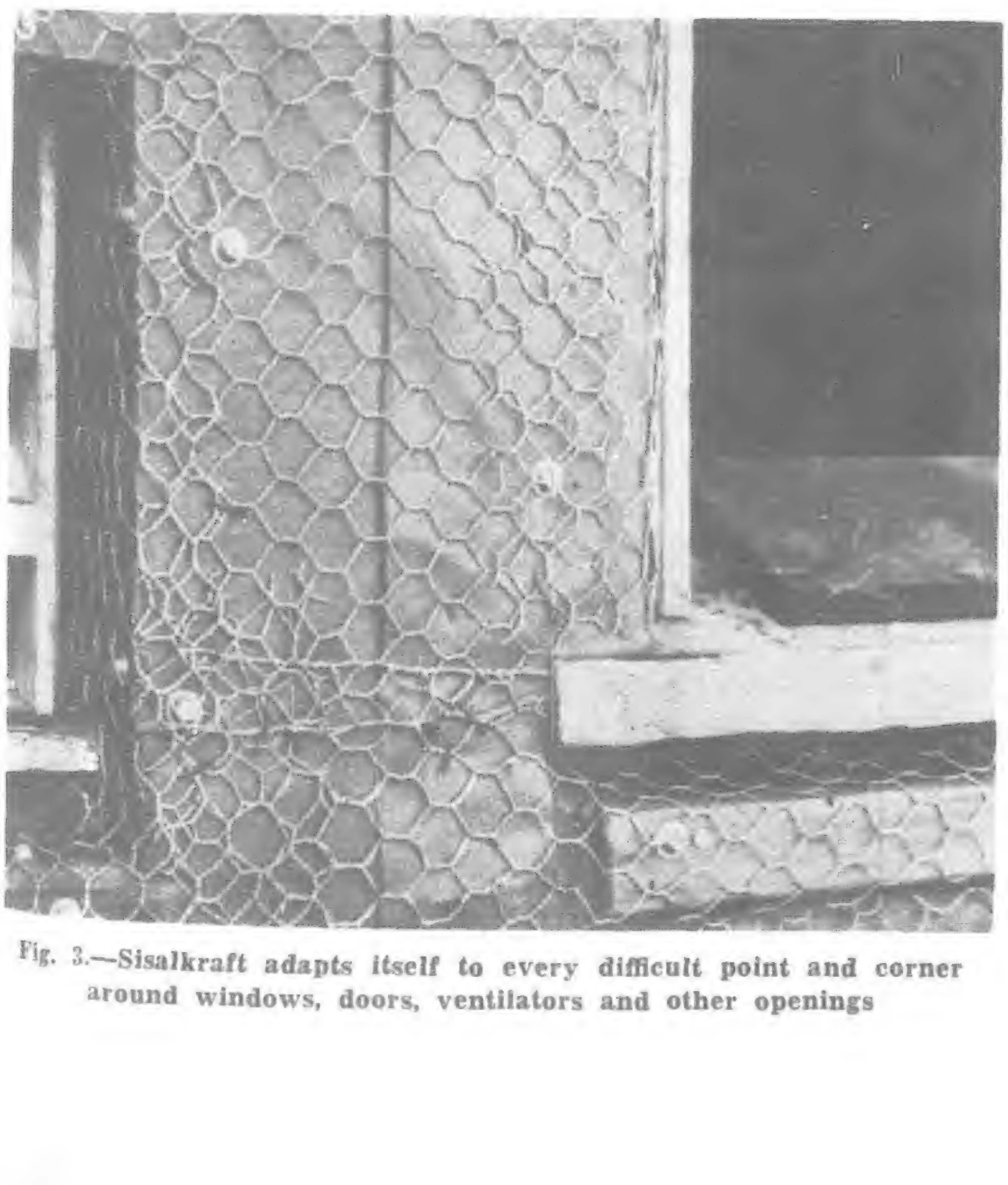


Fig. 3.—Sisalkraft adapts itself to every difficult point and corner around windows, doors, ventilators and other openings

Fig. 4.—Sisalkraft over sub-floors keeps dampness, dirt and bugs away. Warping of hardwood floors, creaking, checks and cracks are prevented. Should be carried up under skirting

Fig. 6.—Sisalkraft fends off weather attacks as storey builds upon storey

inches and covering them with loose gravel or sand. Sometimes these lap joints are cemented, as is the practice in the use of this material indoors. A long wearing surface is the result of this slow curing and the elimination of the tendency of the surface to checking and dusting. From seven to twelve days is the usual time required, but this may vary according to local conditions.

Many Uses in all Types of Building Constructions

The builder or owner thinks of building paper as unimportant because it represents so small a part of the total cost of the building, but the architect knows that the chief function of building paper—to exclude air and moisture—is as vital as that of any material in the building. These functions cannot be performed if the paper tears easily or disintegrates rapidly when subjected to moisture. Air simply cannot penetrate Sisalkraft and the layers of asphaltum form a perfect barrier against moisture, in fact a container made of Sisalkraft will hold water for months.

Fig. 7.—Sisalkraft protects fodder and food crops stored in the open

Only a few of the hundreds of applications may be mentioned here. In the first place, one man can apply it even in a high wind. No battens or cleats are needed as it is put up with broad head roofing nails. In side walls this paper is found to be ideal applied directly over the sheathing and under the weather boards or whatever outside finish is used. Laid over the sub-roof it is especially valuable when corrugated iron is used for here its insulating qualities come into play and it also prevents condensation drip and retards the passage of heat. It is laid over the sub-floor crosswise to the finished flooring and turned up under the skirting, forming an effectual barrier against drafts and by retarding the passage of moisture from below preventing creaking and warping of the finished floor.

In the construction of large buildings Sisalkraft is used for knocking up construction shanties, for the temporary closing of window and door openings, for the protection of scaffold courses and materials stored on the job, and, of course, for the protection of windowsills, wainscoting, finished floors, etc. during the period of construction. One of our illustrations shows a large building in which one storey is protected by the method described above.

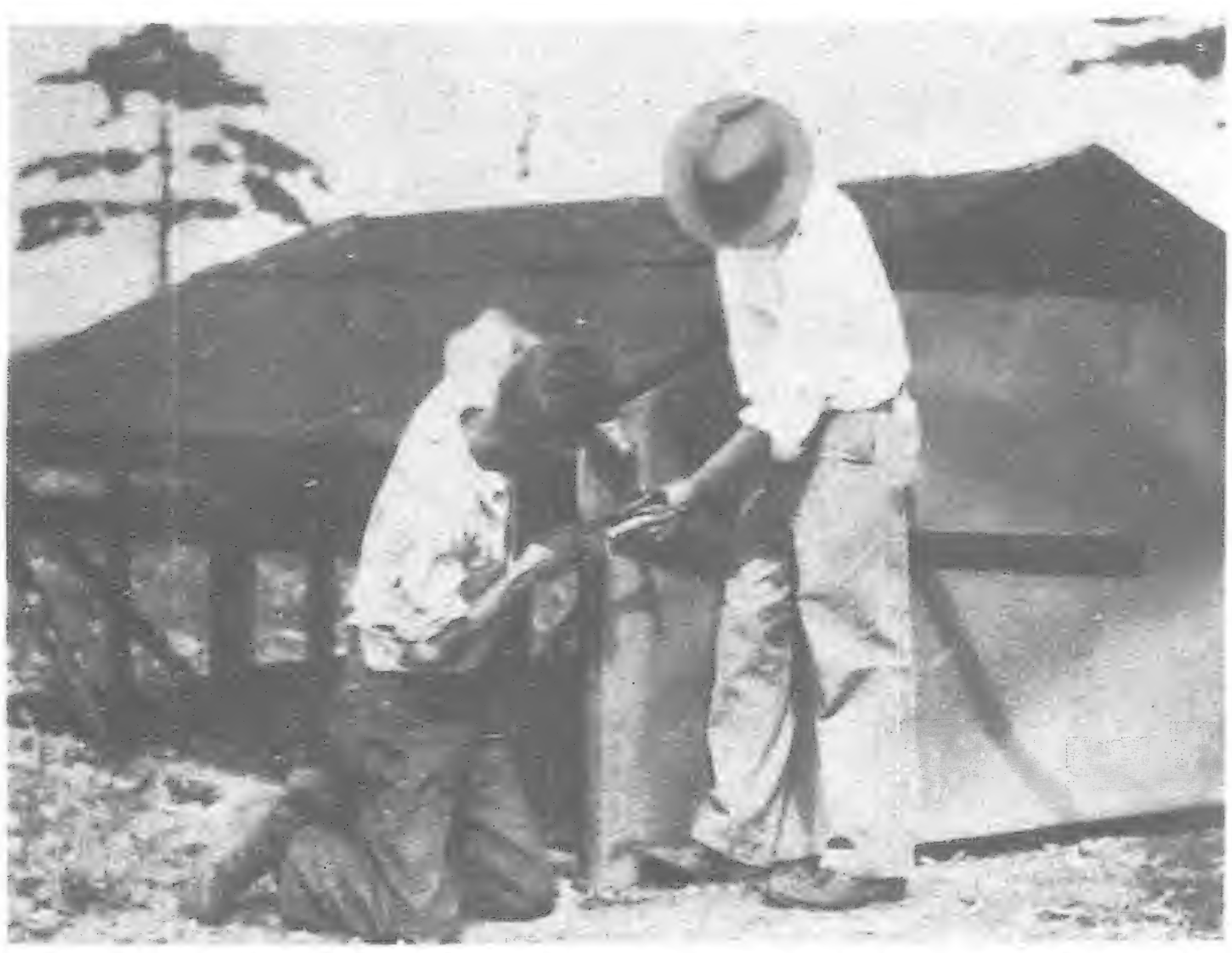


Fig. 5.—Sisalkraft makes weather—wet—wind shelter on poultry and lambing ranges

Sisalkraft in Agriculture

The uses of Sisalkraft in the many branches of agriculture are actually without number. As new applications are constantly developed, uses described above will occur at once, but in addition the product has a great value in many other directions. It covers crops stored in the open, it is extensively used in the sun and air curing of fruits and vegetables, many agricultural products are protected by Sisalkraft when in transit, shelters for poultry, lambs, young pigs are easily knocked together, three sides lined with Sisalkraft, easily transported from spot to spot. In the Western United States Sisalkraft is even used for making diversion gates to direct the water flow in irrigation channels.

In Refrigeration Practice

This paper is finding very wide use for lining refrigerator cars, refrigerator trucks and in the construction of cooling rooms. Here lies the value of Sisalkraft in the making of dead air spaces. The company's engineers will be very glad to furnish specific data for such applications. It has been shown that insulating materials retain their efficiency when sealed in Sisalkraft envelopes.

General Uses

It may be said that sisalkraft is a protecting material with all the value of a tarpaulin or a sheet of canvas, costing much less, lighter in weight and easier to handle. Thus it may be used to cover open goods vans, protecting merchandise in transit, under rugs, linoleums and carpets, wrapping luggage on motor trips, as a ground covering in tents or under sleeping bags—in short, wherever a tough, waterproof, reinforced paper is required.

Demands of the Far Eastern markets are being served from the Australian factory through the following distributors:

Nishikawa Co., Darien, Manchoukuo
Andersen, Meyer & Co., Ltd., Shanghai
Norton & Harrison Co., Manila, P. I.

from whom samples and all data may be secured. However, the company invites correspondence direct with the home office The Sisalkraft Co., 205 West Wacker Drive, Chicago, Illinois, U.S.A.

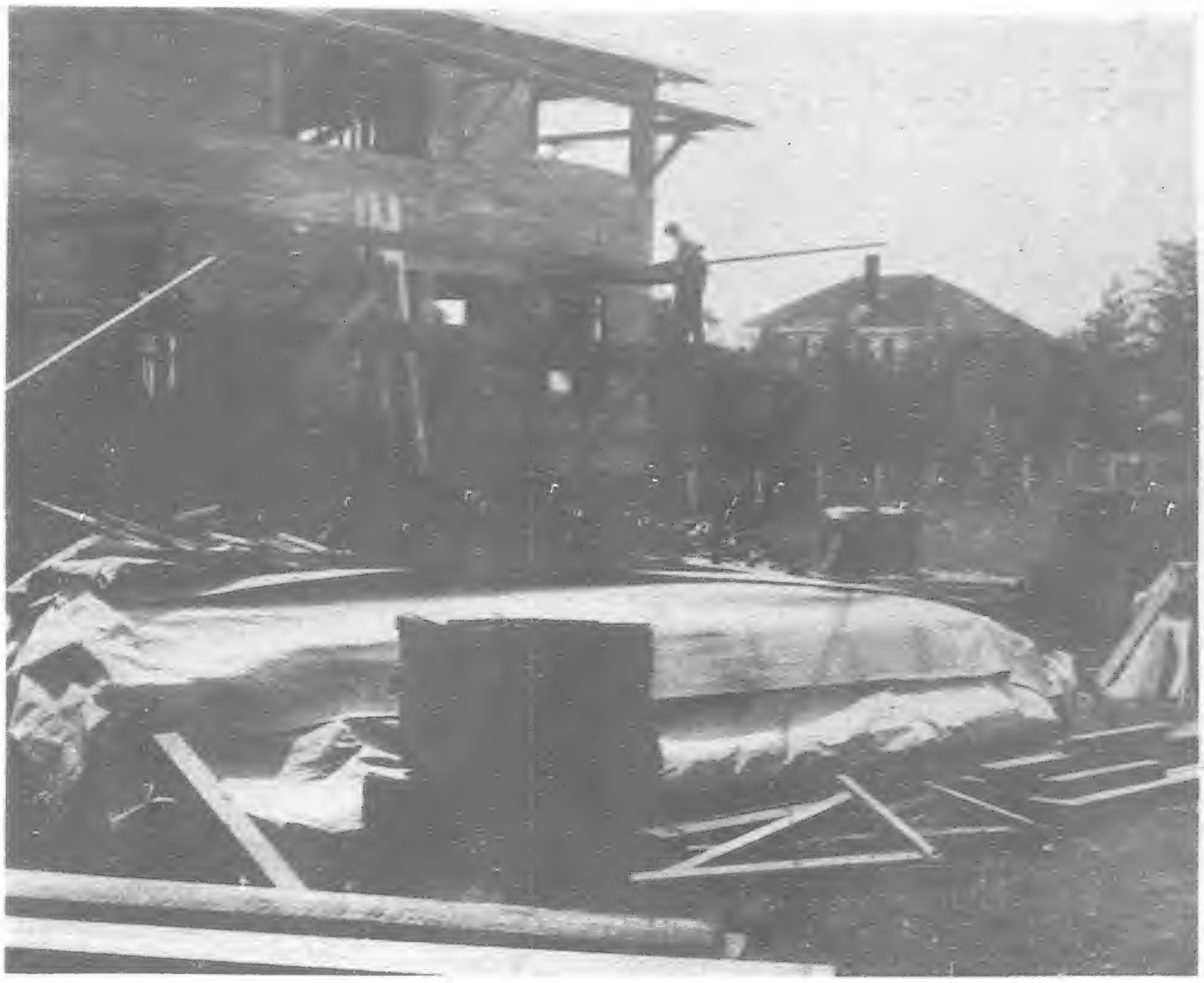


Fig. 8.—Sisalkraft protects materials and goods—in place or in transport

Sisalkraft comes in rolls 36 inches to 84 inches wide, fitting all road, agricultural and construction requirements.

Japan's £80,000,000 Imports

The anxious controversy concerning Japan's competitive exporting power too frequently smothers another and not less important feature of her commercial activities. As might be assumed, yet is usually forgotten, large exports mean large imports, and Japan is conforming to this economic law as completely as any other country in the world. To-day, her imports are valued at between £80,000,000 and £90,000,000, and her exports at £113,000,000 per annum.

The very process of Westernization, which in Japan has been carried out with such thoroughness, and which people of limited vision regard as a direct cutting off of the market for Western manufactures, has actually created a multitude of demands on European and American factories which could not otherwise have existed. True, Japan has doubled her output of motor cars in one year, her artificial silk production has gone up by 40 per cent., and other similar advances could be quoted; but she is also increasing her imports of many classes of goods, and these are not merely confined to lines which she does not manufacture herself, but include a number usually regarded as among her principal exports, the truth being that her output of these is insufficient to cover both export and internal needs.

Moreover, Japan's principal industries are of a character for which she is compelled to import both raw materials and mechanical equipment. Thus, her largest group of imports, covering more than one-third of the total, consists of wool, cotton, yarns, threads, twines, fibres, etc., Great Britain and the British Dominions taking a leading part in supplying the principal among these items.

Equally, in spite of having built up a large steel and iron industry with a production of nearly 2,000,000 tons, Japan still requires to buy from outside an annually increasing quantity of special steels, plates, hoops, shapes, etc. A typical example in another category, and one which indicates the effect of extending local industrial processes, is the steadily expanding call for electric welding wire, of which only small quantities are manufactured in Japan.

Coming to more general manufactures, the widening adoption of European clothing and habits is reflected in Japan's substantial purchases from abroad of leather goods, including men's footwear and belts, as well as harness, trunks and bags—a class of imports unaffected by the equal growth in imports of hides and skins, including sole leather, medium and light-medium uppers, etc.

The development of interest in sports and games is also having a marked effect both on domestic production of various requisites and on imports. Among the items in demand are golf clubs, bags and balls, leather golf jackets, sweaters, boots and gloves; billiards balls and cues; bathing suits and caps; tennis racquets to a smaller extent; and even skis and skates—a number of artificial ice rinks having been opened in recent years. Association footballs are made locally in sufficient quantities to meet the demand, but rugby balls are imported. Another game which has acquired a certain hold is badminton. Incidentally, it is satisfactory to note that Great Britain holds a good position as a supplier of most of these requisites, particularly golf balls, for which there is an excellent opening for any well-advertised make.

It is interesting, also, to note the success achieved by British safety razor blades on the Japanese markets, these being definitely superior to those of local make, and competing well in price.Even the cheapest British blades are preferred to Japanese productions, which are so inferior that their makers only keep them in limited demand by frequent changes of name and package; while in the better classes imported razors and blades meet no serious competition at all.

Although possessing an important paper-making industry, with a production of over 650,000 tons per annum, Japan, nevertheless, imports something like 60,000 tons, including a certain amount of writing paper, mainly for making up into tablets, and also a limited quantity of superior grades for the use of the better classes and foreign residents and visitors. Even wallpaper is imported for use in Western-type buildings, local producers being unable to compete with medium and cheap qualities from abroad, though they make a small quantity of high-grade papers which compete successfully. These various items by no means cover the entire scope of Japan's import trade, but they are of a character to show that many valuable and not widely recognized openings exist for European and American goods there.—*The British Export Gazette*.

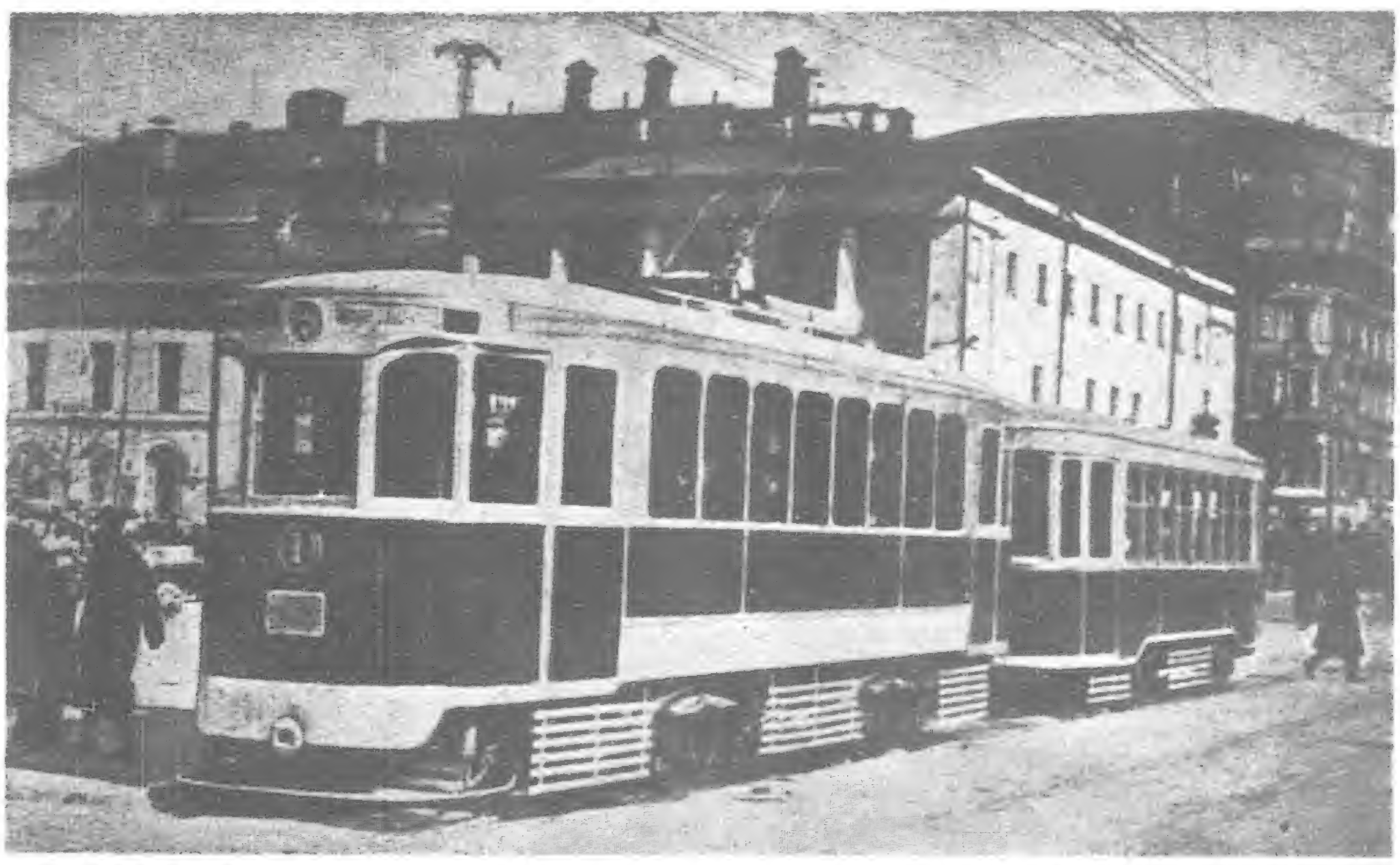
Soviet Transport in the Second Five Year Plan*

By MARGARET MILLER, Ph.D.

THE rapid pace of development characteristic of all branches of Russia's national economy during the first Five Year Plan laid particularly heavy demands upon her transport system, which, from Tsarist days, had been notoriously insufficient as compared with the needs of the country for transport facilities. Heroic efforts were made to satisfy these demands, but in spite of relative successes, the *rate* of progress in transport persistently lagged behind the rate of progress in other spheres of economic activity. The success of the second Five Year Plan must therefore depend to a large extent on how far it proves possible to "liquidate" this comparative backwardness of the transport system.

Changed Aims in Transport

From its Tsarist predecessor the Soviet Government claims to have inherited a transport system which was based partly upon economic aims—the export of raw material and agricultural produce on to world markets—and partly upon strategic considerations—the subjugation of the outlying parts of Russia's vast domains, and recurrent wars connected with Imperialist expansion. Hence transport development was directed towards the ports of the Baltic, Black and Azov Seas, and the Pacific Ocean, and to the land frontiers of Germany, Austria-Hungary and Rumania, the interest of internal consumption being relegated to a position of secondary importance. Soviet economic policy is radically different, and bases itself rather upon internal economic development, thus imposing new tasks on the transport system. The eastward colonization drive for example, which is to be continued during the second Five Year Plan, lends particular importance to the strengthening of the transport links connecting European Russia with the Urals, Siberia and the Far East. The policy of industrialization is reflected in the stress laid upon the need for improving communications between the Don Basin and the newer industrial centers in the Urals and in Siberia, with Central Russia and the regions of the North West.



One of the New Trolley Buses Operating in Moscow

A Unified Transport Net

A fundamental aim underlying the whole of transport development is that of unifying and co-ordinating all forms of traffic movement, by rail, road, air and water, so as to evolve system which shall be completely harmonious and equal to all the demands made upon it. The absence of uneconomic competition inherent in a planned economy removes what is still a serious obstacle to co-ordination under capitalist conditions. It therefore becomes possible to lay down varying "spheres of influence" for different forms of transport, reserving the railways mainly for long hauls and heavy bulk traffic, rivers for shorter hauls and similar traffic, roads for short hauls of light goods, air lines for valuable freight and long-distance passenger movement. As a result, the utmost service is secured from the transport net as a whole. Traffic services also become an integral part of the general economic plan, and their growth is harmonized with progress made in other spheres, such as those of electrification, irrigation, industrial and agricultural development.

Railways

By far the greatest proportion of transport work still falls upon the railways, and special importance therefore attaches to the pronouncements of the 17th Party Conference on the general lines of development to be followed by the railway system during the second Five Year Plan. The main function of the railways is to serve as a means of inter-regional communication, between the European and Asiatic parts of the U.S.S.R., and for linking up the Don Basin with northern Russia. Freight turnover is expected to increase from 169 milliard ton kilometers in 1932 to 300 milliard ton kilometers in 1937, special attention is to be paid to the extension of the railway net with a view to developing the outlying regions and the various national republics of the U.S.S.R., and some 11,000 kilometers of new lines are to be built. In total, the railway net is to increase at a rate of development greater, it is claimed than any achieved under capitalism, even in the heyday of railway construction.

These ambitious plans are to be carried out by means of a twofold effort embracing (1) the construction of new lines, and (2) the reconstruction of existing lines.

(1) The construction of new lines reflects both the industrialization policy of the Soviet Union, and its policy of expansion Eastwards. The lines to be built are those linking up the coal and metal regions in the Kuznetsky Basin, the Don Basin and Krivoi Rog, with Central Asia, with the Caucasus district and with Kazakstan. Special importance is attached to the new lines which will improve communications between Central Asia and European Russia (e.g., the Karaganda - Balkhash line and others) and those which are to link up the Urals with Central European Russia. Northern European Russia with its important timber industry is also to receive attention, and new lines are to keep this region in closer touch with the Northern Urals, Western and Eastern Siberia, and the Far East.

(2) Existing lines are to be reconstructed with a view to maximizing their freight-carrying capacity, and electrification forms an important part of this scheme. It is hoped to electrify no less than 5,000 kilometers of railway line during the second Five Year Plan, including portions of the Siberian main line, the main lines connecting Krivoi Rog with the Don Basin, the main lines Murmansk-Leningrad-Moscow-Rostov with branch lines Armavir-Prokhaladnaya-Perevalnaya, etc. Electrification is to be applied on certain sections of these lines, where freight turnover is particularly heavy, or where the gradients are too steep for steam locomotives, also round crowded terminals such as Moscow, Kharkov, Rostov-on-Don, and in parts of the Urals and Trans-Caucasia where natural conditions make the use of electric locomotives absolutely essential, even with the present freight turnover.

Further elements in the plan of reconstruction are concerned with the rolling stock. Locomotives of a more powerful type are

British-Russian Gazette and Trade Outlook

to be introduced on the most important lines, as for example the Moscow-Rostov, Moscow-Orenburg, Leningrad-Perm and others. The new Lugansk locomotive plant is at present at work upon super-powerful F.D. 1-5-1 freight locomotives which will increase train performance by between 15 per cent and 175 per cent. Diesel locomotives are to be made available for use in the arid regions of Central Asia, Kazakstan, the Northern Caucasus. The introduction of large goods wagons is also contemplated, these to be specialized according to the type of transport work undertaken. Further, the rolling stock is to be equipped with various technical improvements such as automatic brakes and automatic coupling: and the processes of loading and unloading are to be mechanized as far as possible. Altogether the satisfaction of these requirements demands the following production during the second Five Year Plan: 4,000 powerful locomotives, 2,000 goods wagons for electrified lines, 1,000 Diesel locomotives, 3,000 class E Locomotives, 260,000 three axle goods wagons, and 50,000 three axle passenger carriages. Improvements in the permanent way include the extension of automatic block signalling, the building of new bridges across the main waterways and the reconstruction of existing bridges.

Waterways

The ambitious plans for the development of water transport in the second Five Year Plan are demonstrated by the following table showing the increase in the amount of goods to be carried by sea and river between the beginning and the end of the Plan.

	Freight turnover of water transport. In milliard ton/kilometers.	
	1932	*1937*
Water Transport including	44	115
(*a*) River	26	64
(*b*) Sea	18	51

Passenger traffic is to increase from 46.6 million in 1932 to 113.9 million in 1937, and navigable waterways are to rise from 84,000 kilometers in 1932 to 101,000 kilometers in 1937. In European Russia the main function of the waterways is to relieve congestion on the railways, particularly in inter-regional traffic from north to south ; in Siberia and the Far East they are specially important in that they provide facilities for transport in regions at present without any other means of communication.

Transport by sea plays an important part in the Soviet's northern regions and also for inter-regional communication between north and south (the Baltic and Black Seas), and between European Russia and the Far East (the Black Sea and the Pacific Ocean). Besides the increase in freight turnover referred to earlier, sea-borne passenger traffic is to increase from 3.5 million in 1932 to 9.4 million in 1937. By the end of the Plan it is also hoped to lessen the present dependence on the use of foreign vessels for the carriage of goods in the import and export trade.

To enable water transport to meet the demands laid upon it, much progress will have to be made on the technical side. The type of vessel in use is to be improved, as also its equipment, and the greatest possible degree of standardization is to be introduced in both. Vessels specially adapted for the work which they are to perform are required, for example, refrigerator ships, tankers, ice-breakers. Canal construction is to continue: and in this connection the completion of the White Sea-Baltic Canal may be mentioned as an outstanding event (opened August, 1933). Its navigable length from Lake Onega to the White Sea is only 227 kilometers, but it saves over 4,000 kilometers on the old roundabout sea voyage. Further canal projects which it is intended to complete before 1937 are those of linking up Moscow with the Volga, the Volga with the Don, and the Caspian and Black Seas through Manykh. It is hoped to reconstruct existing, and build new, river and sea ports, with up-to-date technical equipment, facilities for ship-repairing, radiotelegraphic equipment, and mechanized facilities for loading and unloading. The plan aims at joining up the important river basins with other regions of the country by connecting them, at their principal navigable points, with the railway system. Two underlying ideas in the development of water transport are these: to introduce electrification throughout the whole system, in equipment, transport processes, loading and unloading work; and to relate the development of the water resources of the country to general economic development, keeping in view transport as a whole, projects of power production, irrigation schemes, water supply for towns, and the fishing industry.

Road Transport

Highways, at present in a very unsatisfactory condition, are the medium par excellence for intra-regional communication. The function of road transport is partly auxiliary, it carries freight from its place of production to the railway at one end, and from the railway to the main centers of distribution at the other end: and partly independent, it relieves rail and river transport of short uneconomic hauls and journeys involving frequent changes. In particular, well built roads are felt to be a necessary concomitant of the transfer of agriculture to enormous collectivized farms and the consequent necessary movement of large quantities of produce.

Development in this connection first of all demands road construction. Main roads are to be built, especially in districts lacking rail and water transport, and in the new industrial regions, existing roads are to be improved, bridges built, measures introduced to increase safety on the roads and their utilization all the year round. Then comes the task of securing motor vehicles to run on these roads. The Soviet Union expects to produce 400,000 automobiles per annum by the end of the second Five Year Plan, thus taking second place after tne U.S.A. This increased production is to include the newest types of vehicles, for example Diesel motors, of both light and heavy make, specialized for the different types of transport work to be performed and with mechanized equipment for loading and unloading. Garages and service stations will have to be built, with special attention to standardization, repair work must be improved and the systematic overhaul of cars, and the replacement of worn parts will have to be more stringently enforced.

As a result of all these efforts, freight turnover on the roads is to rise from one milliard ton/kilometers in 1932 to 16 milliard ton/kilometers in 1937, a much more rapid increase than that contemplated for any other form of transport.

Air Transport

In 1932 Russia's air lines carried 31,600 passengers, 454 tons of mail, and 552 tons of freight, and immense importance is attached to their further development during the second Five Year Plan. In the Soviet Union the air service is relied upon to perform many different tasks. On the economic side, it serves to connect Central Russia with the outlying parts of the country especially in Central Asia and the Far East, and with the important industrial districts: it provides inter-regional express service auxiliary to other forms of transport and also gives an independent service in regions to which the railway has not yet penetrated: its main use is for the movement of passengers, mail and valuable merchandise of small bulk. On the cultural side it helps to carry out the national policy of the Soviet Union, to bring the most isolated districts into cultural contact with the rest of the country, and to "liquidate" the antagonism of town and country.

The end of the second Plan should see a thorough-going reconstruction and rationalization of the Soviet's civil aviation fleet. The aims kept in view are the following:—To build new and specialized types of aeroplanes, for the carriage of passengers and mail, for use in agriculture (sowing of seed, destruction of insect pests), industry (rapid carriage of valuable freight, etc.), forestry (detection of forest fires); for use in aero clubs and for educational work. It is intended also to build aeroplanes with Diesel and electric motors. Along with this must go aerodrome development, to allow of all-year-round and day-and-night flying, the mechanization of aerodrome service in loading and unloading operations, the provision of repair service. These improvements are expected to diminish the losses at present incurred in operating the air lines, which are to increase in length from 32,000 kilometers in 1932 to 85,000 kilometers in 1937.

Prospects for British Supplies

It will be seen that the second Five Year Plan provides for a sweeping process of technical reconstruction in every phase of transport activity. This is characteristic of the general policy for all economic progress during this period. The first Plan concentrated on new construction sometimes at such a feverish pace

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How Land is Won from the River at Shanghai*

SOME idea of "warping" in the river Whangpoo, on which Shanghai stands, may be gathered from the fact that the total quantity of mud entering the river per annum is some 10,000,000 tons, of which about 8,000,000 flows out with the ebb, leaving, say, 2,000,000 tons behind. Of this last about 1,500,000 tons has to be dredged between the normal lines of the river, and the remainder is on foreshores and in creeks.

The work of the Whangpoo Conservancy Board in connection with dredging is well known, but its reclamation works are not so much in evidence, being mostly away from the more frequented parts of Shanghai.

Dr. Herbert Chatley, Engineer-in-Chief to the Board, in the course of a lecture he recently gave to the Shanghai Association of the Institution of Civil Engineers, mentioned the striking fact that the Board is now able to fill in as much as 960 mow of land each year and that since 1916 a total of about 4,000 mow had been filled in to high levels.

The Whangpoo Conservancy Board, up to June 30, 1933, had dredged about 46,000,000 cub. yds. barge measure, or 33,000,000 cub. yds. consolidated mud, and over 90 per cent of this has been pumped ashore. The Board has two barge unloading pumps, the main engines of each having a pumping capacity of about 700 cub. yds. (barge measure) consolidated mud per hour. Prior to pumping the area to be reclaimed is dyked with good coherent mud to a level about $1\frac{1}{2}$-ft. above the final height of the fill. The water-side surface of the dyke is protected with loose rubble set on reed temporary protection. If placed in water the dyke is founded on willow brushwood fascine mattresses and provided with a rubble stone toe dyke to underpin the rubble protection. At the present time it is cheaper to build the dykes by manual labor than to use mechanical plant. Dredged mud is not very suitable for dyke building and even if it were, mechanical dry unloaders are more expensive than actual dredgers, owing to the tidal slope and "reach" conditions.

Timber sluice boxes with adjustable weirs are placed at convenient places in the dykes to draw off the excess water and pipes lead from these back to the river or to creeks. The effluent contains fine material aggregating sometimes 10 per cent by weight of the pumped in material, but the loss of volume is much less than 10 per cent, and this fine material remains to a great extent in suspension in the river water and is carried away by the ebb currents. One interesting result of this washing out is that the fills tend to dry out sandy and are not suitable for grain cultivation for some time after completion.

Cost of Pumping

The gross cost of pumping is about \$0.10 per cub. yd. barge measure, or, say, \$0.14 per cub. yd. consolidated, but the Board now only charges \$0.01 per cub. yd. barge measure, so as to encourage private owners to fill. The cost of the dykes, pipe lines, etc., averages about \$0.20 per cub. yd. barge measure of the filling. For the ordinary ground level condition this means that one mow filled 7-ft. deep will take about 2,600 cub. yds. barge measure, and cost (to the private owner) about \$550 per mow to fill. It may be much less for a large inshore lot and two or three more times this for a property just along the river with a low foreshore, owing to the large volume of the dykes and the greater depth of the filling.

Obviously this is much more than any agricultural value. This brings in an interesting point in connection with flood dyking on a main river like the Yangtze. It is (apart from questions of navigation or good alignment of dykes) generally cheaper to set back an eroded dyke line to a new position and abandon the intervening agricultural land rather than to attempt by protective works to refill and protect the eroded area and retain the land.

One point that is of great interest is the consistency of the artificially filled land. Owing to the fineness of the grains the water is held rather firmly and the weight of the mud only squeezes it out slowly, but in fact the normal ground water level (a little above half tide) is generally reached in three or four years, and after the first year there is a two foot crust. By using land drains (about \$60 per mow extra) the settlement can be accelerated.

Rate of Consolidation

The settlement of a fill after completion depends on the speed of filling, the depth of the fill and the fineness of the material. With a moderately large fill a great part of the consolidation occurs during the process, so that it is usually only necessary to fill up to about one foot over the prescribed final level. If a dry period succeeds the filling, evaporation and surface tension accelerates the surface consolidation, and the surface cracks into blocks, but the withdrawal of the capillary water into the interior delays the drying there. After the surface is dried it is for a time inclined to be blown off by the wind, as the partial removal of the colloid contents by elutriation has reduced the cohesion which would otherwise make the material clumpy. After some time, especially if natural or cultivated vegetation has grown on it, chemical action provides humus and it again becomes cohesive.

Owing to the small permeability of the surrounding dykes, unless land drains are used the fill remains soft for some years, especially if the fill is deep, and the question of loading often arises. Pile friction within the depth of the fill cannot be safely reckoned at more than 100 lbs. per sq. ft. for some time, and surface loading in the early history of the fill should be kept down to about 500 lbs. per sq. ft. Later, as the fill consolidates, the usual local value of 1,700 lbs. per sq. ft. will become possible. Concentrated loading is apt to give trouble on the new filling, as the material is plastic.

The advantages to the land owner of the liquid process are considerable. For large areas (more than, say, 50 mow), the cost is much less than that of solid filling, and the time required to fill it is very much less. No exact ratios can be given, but the cost of large fills (say 100 mow or more) by dry processes is usually at least one and a half times as much as the liquid fill, and the time required for filling some four times as long. When it is considered that a fair day's work for one of the Board's pumps is over 4,000 tons of consolidated mud it is obvious that the speed of the liquid process is incomparably greater than that of dry filling, even after allowing for dyke building.

Pumps Daily Output

In small jobs where the dykes form an appreciable fraction of the volume (and incidentally add to the volume to be filled) the economies of money and time disappear. Furthermore, in a small basin the fluid mixture has not time to settle before it reaches the outlets, so that a large fraction of the mud is lost to the fill and deposits in the adjoining river or creek. This result can be modified a little by intermittent pumping, but this is inconvenient to the Board (whose main object is rapid evacuation of the dredging spoil), and delays the filling.

For small fills, and in places where it is not convenient to use the Board's mud barges, some of the smaller dredgers are occasionally served by ordinary mud boats, and the difference in cost of handling is very striking. A small dredger with a daily output of, say, 400 cu. yds. barge measure will supply about 33 boat loads of three fang each. If it takes one man-day to land a fang of mud from boat to the dump, ten men working in conjunction with one boat take about three hours to unload it; allowing two more hours for going, filling, returning, manoeuvring and waiting for place, this means that each boat takes five hours per round trip, or two round trips per day. Hence at least 17 manned boats and 100 navvies are required to keep the dredger served. As the average actual daily output of one of the Board's pumps is about 15 times the above figures, its operations correspond to the work of at least 250 mud boats and 1,500 navvies!

Pipe Line Dredging

The cheapest method of combined dredging and reclamation in mud is pipe-line dredging, where the dredger by a rotary cutter breaks up the mud, sucks it with necessary water, and forces the

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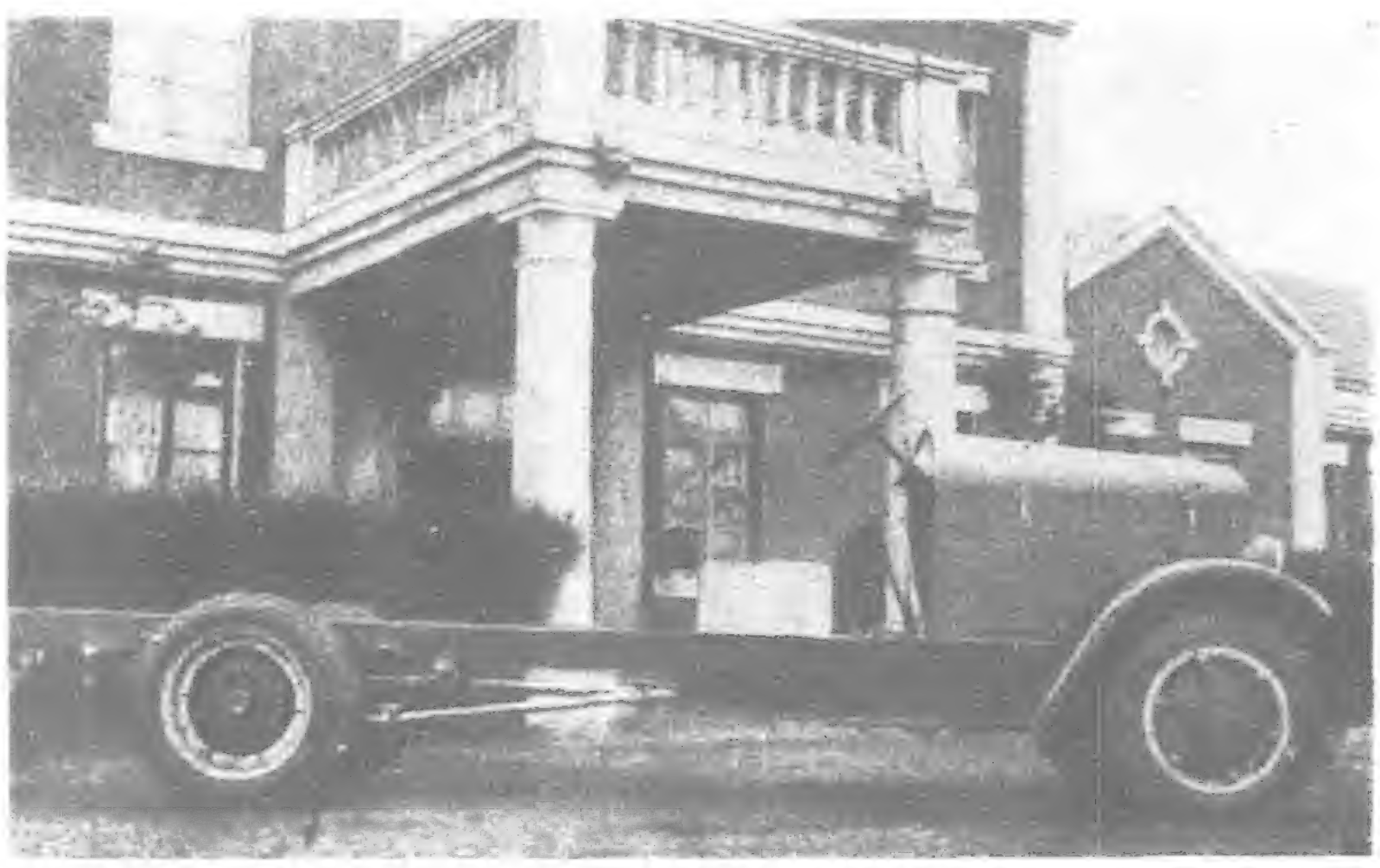
**Eastern Engineering and Commerce*

The First Chinese Built Motor Vehicles*

By D. F. MYERS

ALTHOUGH it may not be generally known throughout China, a very successful attempt was made, in Mukden, to build motor trucks in one of the Government Arsenals. It was my privilege to have been the Chief Engineer of the undertaking which was brought to an end by the invasion of the Three Eastern Provinces by the Japanese Military forces. So far as I know, this is the only case of its kind in China and I may, therefore, be pardoned for the pride which I take in being able to refer to the vehicles which were built as "The First Chinese Built Motor Vehicles."

This undertaking was sponsored by Marshal Chang Hsueh-liang as a part of his Educational and Industrial program in the North-east. A large measure of the success of the undertaking was due to the fact that both Marshal Chang Hsueh-liang and General Y. C. Lee, Director-General of the Liao Ning Trench Mortar Arsenal where the vehicles were built, saw the wisdom of following the example of American motor truck manufacturers in obtaining the major units of the vehicles from recognized manufacturers of such units and then co-ordinating these units in a vehicle which was, in every other essential, of Chinese design. By this procedure we were enabled to avoid a considerable delay in production. We were also able to take advantage of the years of experience represented in the perfected units and thus avoid the expense of failures in untested designs. And, during the early period of construction, we could design and perfect units with which to replace those which we at first imported. Furthermore, we were not required to install such special machinery as would have been needed to make these major units. Since such equipment is very expensive we were also able to start producing vehicles with a rather modest capital.



The first Chinese built Motor Vehicle. Two and one-half Ton Min Sheng Motor Truck built in Liao Ning Trench Mortar Arsenal, Mukden

The undertaking in Mukden may be said to have passed through three stages. First, Preliminary Investigations of Requirements. Second, Designing and Testing. Third, Production. These extended over a period of four years and resulted in the design and production of vehicles which were entirely satisfactory to meet the operating conditions in the Three Eastern Provinces.

Preliminary investigations began early in the Fall of 1927 when General Y. C. Lee conceived the idea of converting the Liao Ning Trench Mortar Arsenal into a factory in which peacetime articles might be produced. He felt that, considering the rapid developments which the Chinese were making in the Three Eastern Provinces, motor transportation was a real necessity. However, the high cost of imported vehicles was effectually preventing the proper development of the highways. General Lee had been singularly successful in the manufacture of heavy guns and carriages and had at his command one of the best equipped factories in the Orient. So, the idea of a Chinese built vehicle appealed to him. His first investigations were with regard to the actual cost of motor vehicles in American and European factories. Knowing this in terms of labor and raw material, he was able to present a plan to Marshal Chang Hsueh-liang.

Further investigations revealed the fact that there was a potential market for several hundred vehicles to serve as feeders for the railways, in addition to those required for the military departments. The plan presented to Marshal Chang included a tentative program of highway building, based on Government controlled trunk roads radiating from certain railway centers and extending into the rich agricultural regions not directly served by the railways. On these roads were to be operated only the motor vehicles under government franchise. The final investigations were in the nature of tests, made with well-known imported motor trucks, to determine the type best suited to the undeveloped country over which they were to operate. One interesting fact which this investigation brought out was that not one of the trucks tested was entirely satisfactory. Vehicles considered to be quite satisfactory under American or European operating conditions could not be depended upon to render the same satisfactory account of themselves when operated by Chinese drivers over the roads found in the Three Eastern Provinces. The cause for this was obvious: European and American trucks, particularly the latter, were designed for road speeds up to fifty miles per hour over roads as smooth as a floor. When these trucks were driven at speeds not to exceed twenty-five miles per hour, it was only to be expected that the economy would be very poor. Nor could the engines, designed to give their maximum torque at speeds up to 2,000 rpm, develop full power at such low vehicle speeds. Much less could the springs, designed to carry the maximum rated load over perfectly smooth roads, be expected to carry even greater loads over the atrocious cart roads of the Three Eastern Provinces. To expect perfect performance from these imported vehicles under such conditions was as absurd as to expect heavy draft service from a spirited race horse.

Designing and Testing

After the preliminary investigations were made, it was decided to import several Foreign made motor trucks, in addition to those already owned by the North-eastern Army, for the purpose of further investigation and tests to determine the weaknesses which would show up in these under the rigorous services to which trucks were subjected in the Three Eastern Provinces. The main results of these investigations were as follows:

(1) It was found more practicable to use vehicles of the so-called "Heavy Duty" type rather than those of "Light Duty." It was found that the engines and other heavy units of these vehicles, being designed especially for heavy service, were much more satisfactory than were the units used in the light duty trucks.
(2) That the imported trucks were all geared to run too fast for the roads over which they were to operate.
(3) That most of the heavy duty trucks were too long to negotiate the short turns of the narrow roads.
(4) That with one exception, all the trucks were useless in the sand which was encountered.
(5) That none of the trucks had sufficiently strong springs to withstand the shocks of the rough roads.
(6) That most of the Foreign designers, having unlimited road widths, had been content to use wider tread axles in order to accommodate dual rear tires. Most of the vehicles had treads of over seventy inches and widths up to ninety inches over the outside of the tires.
(7) That the pressed steel disc wheels, ordinarily used on imported vehicles, could not be kept tight on the hubs when subjected to the hard service required in the North-east.

*Journal of the Association of Chinese and American Engineers

These facts, and others, brought about our determination to begin at once on the design of a vehicle in which as many as possible of these faults would be corrected. Having at our command a very well equipped factory, we were in no wise limited as to manufacturing possibilities. However, in order to get into active production as quickly as possible, it was deemed advisable to import, for the initial year's production, such units as engines, rear axles, transmissions, electrical equipment and tires.

Actual design work began in March, 1930, and in May, 1931, the first vehicle was finished. During this time negotiations had been carried on with the manufacturers of the engines, rear axles and transmissions; designs perfected; more than one thousand drawings made; many hundreds of parts, ranging from small bolts to steel wheels and frame castings, made; and the vehicles assembled. It was a really proud day for the Engineering Staff when this truck, the very first one ever produced in China, rolled out of the assembly building under its own power. This vehicle was very thoroughly tested under loads up to five tons (it was rated at two and a half tons) without the failure of a single part. At the end of these tests, this truck was placed in a room to itself and suitably decorated with signs stating that it was the first Chinese-built motor truck. It was to have served as an example of what might be accomplished in China when men of real determination set to work. It was not destined to remain long in this honored position, however, for it was confiscated by the Japanese Army in the invasion of the Three Eastern Provinces.

Production

During the period devoted to designing, careful investigations were made with regard to the cost of the various parts and units so that, by the time the first vehicle was completed, accurate estimates as to the cost of production were available. From these it was determined that with a capitalization of Mex. $750,000.00 it would be possible to enter upon a production of fifteen vehicles per month over the eleven working months of the Chinese year. This sum was considered sufficient to cover the initial cost of materials needed, labor and overhead for the first year and the general running expenses including the rental of the factory buildings and equipment. Although the rate of exchange worked unfavorably against our original estimates, we found that we were likely to be well within this amount at the end of the first year. Part of this was due to the great reductions which we were able to obtain from foreign manufacturers when our purchases were made without the medium of a middleman. These prices, particularly on tires and engines, were considerably lower than the wholesale prices of similar articles, being the same as the "original equipment" prices quoted to foreign assemblers.

With the exception of a few refinements in appearances, such as the use of an aluminum shell on the radiator, a slight change in the shape of the hood and a change in the shape of the spokes of the cast steel wheels, no changes were made in the original design when production was started. It was found impracticable to change the only really objectionable feature, the width of the tread. This was due to the fact that we did not have time to design and build our own rear axle and it was impossible to get a narrower tread axle from a foreign manufacturer. This was to have been our next job of design work.

We determined, from the first, to limit our production to two sizes of vehicles. These were rated at two-and-one-half tons and three-and-one-half tons respectively. The only difference in the designs of these vehicles, other than the sizes of the components, was in the type of the rear tires, those of the larger truck being solid and those on the smaller being dual pneumatics. The size of the brakes on the larger truck precluded the possibility of using pneumatic tires. In fact, there was a bit of doubt as to the advisability of using pneumatic tires in regions where adequate tire service was not available and we were prepared to supply solid tires, when and if it proved necessary, on either size of truck.

The following specifications will give some idea of the vehicles as produced and the accompanying photograph of the two-and-one-half ton vehicle shows the symmetrical design of the chassis.

SPECIFICATIONS OF MIN SHENG TRUCKS

	2½ ton.	*3½ ton.*
WHEELBASE	142 inches	164 inches
ENGINE	six cylinder	six cylinder
Engine bore	3⅜ inches	3⅝ inches
Engine stroke	4 inches	4½ inches
Torque	135-ft. lbs.	172-ft. lbs.
Brake horse-power	61½	70½
Piston displacement	215 cu. in.	260 cu. in.
Max. torque developed at	950 rpm.	900 rpm.
CLUTCH (dryplate)	10 inch.	12 inch.
TRANSMISSION	four speed	four speed
SPRINGS (rear)	Made from chrome-vanadium steel.	
Width	3 inches	3½ inches
Length	54 inches	60 inches
Number of leaves	15	17
REAR AXLE	"Relay" type	"Relay" type
BRAKES (four-wheel hydraulic, emergency on drive shaft)		
Area	625 sq. in.	805 sq. in.
GEAR REDUCTION (bevel and internal gear double reduction)		
High gear	7¾ to 1	10½ to 1
Low gear	51 to 1	69 to 1
WEIGHTS:		
Vehicle weight	4,300 lbs.	4,800 lbs.
Body allowance	1,200 ,,	1,500 ,,
Load allowance	5,000 ,,	7,000 ,,
Total weight loaded	10,500 ,,	13,300 ,,
REAR TIRE SIZE	30×5 dual pneu.	40×10 solid
NORMAL ROAD SPEED	22 mph	18 mph
MAXIMUM ALLOWABLE SPEED	35 mph	25 mph

Quantity production of fifteen trucks per month was to start with September, 1931. By September 8, 1931, the first production vehicle was completed and shipped to Shanghai to be shown in the Good Roads Show. This vehicle is now the only one left in the hands of the Chinese, being stored in the Engineering Department of the Chiao Tung University in Shanghai. By September 18, 1931, ten other vehicles were practically completed and several others were in the various stages of construction. On this day, however, all activities were suspended owing to the invasion of the Japanese Military forces who confiscated the Liao Ning Trench Mortar Arsenal and all materials therein. Subsequently the Japanese completed the forty-five vehicles which were under construction and used them in their campaigns for the subjugation of the Three Eastern Provinces and Jehol.

Comparative Costs

One of the most natural questions with regard to a venture of this kind is "How did the costs compare with those of imported vehicles?" The following comparison with one of the trucks of identical size imported (direct from the factory) from America will show the saving in cost in the case of the smaller of the trucks.

COST OF IMPORTED 2½ TON TRUCK

Factory net price	U.S.$ 1,522.35
Crating	90.00
Freight to New York	45.00
Insurance and clearance	17.50
Ocean freight to Newchwang	231.50
Invoice c.i.f. Newchwang	U.S.$ 1,906.35
Plus duty paid (12½% invoice)	238.29
Total cost FOB Newchwang	U.S.$ 2,144.64

(Owing to the courtesy of the PMR, the railway freight to Mukden was rebated).

COST OF MIN SHENG 2½ TON TRUCK

Material cost (imported and domestic)	U.S.$724.05
Transportation and insurance	102.30
Labor	129.35
Overhead	194.03
Advertising allowance	47.50
Duty paid on imported material	127.52
Factory profit allowed	132.48
Total cost FOB factory	U.S.$1,457.23

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Dredge Boilers and Malayan Coal

In November last, at a meeting of the Dredging Association of Southern Malaya, in Kuala Lumpur, a paper on the dredge boiler was read by J. Drysdale. The author said that there are various types of boilers on dredges throughout the country, but all of them perform the same function—*viz.*, the generation of steam for use in the power units—and the efficiency with which they do so depends on the particular type of boiler. The majority of the dredges, however, are fitted with the Babcock and Wilcox water-tube boiler and chain-grate stoker and particular reference to this make would seem desirable. The type usually fitted is what is known as the Portable boiler, but with the ever increasing size of dredge and, consequently, size of boiler, this type has almost outgrown itself and now appears more like the cross type marine boiler than the original portable design. In addition to these two types others are used in this country, some on dredges and some in power houses run by dredging companies, so it might be worth while to include a brief description of each.

The hand-fired W.I.F. (Wrought Iron Front) type is the usual land-type boiler. Its suitability for land work is because of the comparatively large steam and water storage available in the longitudinal drum, particularly in the multi-drum types. This type of boiler is made for evaporations ranging from 360 to 40,000 lb of water per hour.

The hand-fired C.T. (Cross Type), which takes its name from the position in which the drum is placed in relation to the section tubes, does not have the storage capacity of the W.I.F. type, but can raise steam more quickly. The C.T.M. class (Cross Type Marine) fitted with chain-grate stoker, superposed superheater, and economizer, all steel cased, is the most general type and is made in many different designs for land purposes and the sizes range in evaporation from about 5,000 to 500,000 lb. of water per hour.

The class P (Portable), which is similar to the C.T., is specially designed for simple transport, although the addition of a chain-grate stoker can be arranged.

These types cover the range met with on dredges although, where an economizer is fitted, it is placed at the back of the boiler instead of being superposed and the superheater is usually below the return tubes instead of above them. The superposed design, however, is a very suitable one from many points of view. In all cases the principle of construction is the same and is one of the main features of the boiler, the entire weight being carried by steel columns and the section tubes suspended from the drum, thus being free to expand without restraint and resultant stresses. In the case of the W.I.W. type the drum is supported at both ends by steel slings suspended from a cross beam carried on top of the steel columns and the sections are suspended from the drum by circulating nipples expanded into the headers at one end and into the drum cross-boxes at the other. In the cross drum types the drum is carried in a saddle which is fitted to a column at each end and one set of headers is suspended from the drum by means of the circulating nipples while the other set rests on rollers carried by a cross beam supported by side and intermediate columns.

In all cases the sections are free to move in all directions and any casing in the form of steel or brickwork is entirely free from supporting stresses.

The boiler sections are constructed by the expanding of steel tubes into wrought iron headers so shaped that the tubes have a staggered formation, which results in more efficient heat transmission from the gases to the water. All tubes are 4-in. diameter and the joints are made by a tube expander which rolls the tubes into their seats. The sections are suspended from the drum so that the tubes are inclined at an angle of 15° to the horizonal.

The superheater, where fitted, is an integral part of the boiler and like the sections is constructed of steel tubes welded into steel or wrought iron headers but in this case the tubes are 1½-in. diameter and one handhole fitting serves each group of four tubes.

After dealing with general boiler practice the author deals with certain characteristics of Malayan coal. He says thato wing to its high volatile content a considerable amount of excess air is required and must be available above the fuel bed in order to consume the volatiles and particles of carbon in suspension in the gases and in this respect some of it acts as secondary air. Secondary air is essential for complete combustion, but there are very few boilers in the country specially equipped for its admission at the proper place. A recent illustration of the importance of secondary air and the effect which it has on the boiler efficiency and coal consumption when using Malayan coal occurred at a power station in Perak when some tests were carried out with a secondary air fitment and the results have been published in the July issue of the *Journal* of the Engineering Association of Malaya. Several tests, some of which the author had the privilege of witnessing, were made with and without the secondary air equipment in commission and comparison between the two sets of tests showed that the boiler efficiency had been increased by about 12% and the coal consumption decreased by about the same figure as the result of the use of specially admitted secondary air. The equipment was fitted to two boilers with chain-grate stokers and super-heaters. It consists of a manifold fitted with a set of nozzles, each of which has a steam injector, and the manifold is positioned across the top of the lintel plate about a foot from the front and the nozzles, which are six in number and are pitched equidistant throughout the width of the stoker, project downward through the arch. The lower ends of the nozzles are elbow-shaped, slightly bell-mouthed and point towards the back of the furnace. The steam injectors draw the air through the manifold and force it through the nozzles into the combustion chamber where it mixes with the combustibles and improves the furnace efficiency. The steam which is superheated also serves to preheat the air.

This equipment is very suitable for admitting secondary air to a furnace which has not been specially designed for it and eliminates the necessity for a fan which would be required to admit it in the usual way. All modern furnaces designed for the combustion of bituminous coals, incorporate secondary air arrangements and the method adopted is similar to that described above, but the arch is specially designed with a step positioned about 2-ft. from the front and the air is admitted at the step. The air is generally drawn from an air heater by a fan and is delivered to the secondary air ports or nozzles under pressure. Deflecting vanes should be fitted in the throat of the nozzles so that a whirling motion is imparted to the air as it enters the furnace. The whirling motion improves the inter-mixture of the air with the volatiles and carbon particles and increases the speed and extent of combustion.

A very interesting application of this system has been made to a boiler in this district. The boiler is a hand-fired type and the furnace has been redesigned with an extension at the front which incorporates a stepped arch and secondary air nozzles. It is intended that induced secondary air should be tried, but provision has been made for a pressure supply. The air will be supplied underneath the lintel plate and will travel over the hot brickwork of the arch and will be to a certain extent preheated before it reaches the nozzles.

Especially when using Malayan coal the conditions at the front of a stoker are very delicate and have to be watched carefully. The effect of wet coal and the function of the arch have already been referred to, but here it may be emphasized that as high a temperature as possible must be maintained at the front of the arch and the lower the arch is the more sensitive it is. The increased heights recommended recently are necessary to provide sufficient volume above the fuel bed and to enable combustion of the volatiles to take place and therefore to maintain heat in the arch so that it may be reflected on to the incoming fuel. With a low arch the small volume has to deal with the same quantity of products as with a higher arch and the resultant increased velocity carries them further back before combustion takes place; the hot zone is also further back and the length of the arch is virtually shortened. Any air leakage at the front of the stoker further aggravates the trouble. The opinion that secondary air could be delivered here is fallacious. There is only one place to deliver secondary air, either preheated or otherwise, and that is where the surrounding temperature conditions can stand its initial cooling effect. The back end of the furnace, while not so sensitive as the front, is equally important and is generally a fruitful source of waste as the result of ingress of

excess air, which cools the furnace considerably and carries away useful heat in the flue gases. There is no need for frequent operation of the ash door and it is desirable that a good layer of ash should cover the door, in fact there is no reason why the ash should not be allowed to pile up over the door and for that matter the ash plates also, provided that it is ash and not partly consumed coal. If the latter occurs, then the ash door and plates run the risk of being badly burned.

Although Malayan coal is a free-burning coal and does not slag easily, a certain amount takes place on the brickwork at the sides under the arch in the hottest zone and accumulation sometimes takes place to such an extent that interference with the fuel bed results and centre tailing is caused. The usual method of removing this slag is with the hand slice, but this is awkward and often causes damage to the brickwork.

Slicing links, a special fitment that can be obtained for any stoker, will overcome the trouble and this fitment has been in operation at a power station in Selangor for some time now and the results are very satisfactory. It was at first thought that the life of the links would be short, but no renewals have been required during their 12 months' operation.—*The Mining Magazine.*

Soviet Transport in the Second Five Year Plan

(*Continued from page 371*)

that quality was sacrificed to quantity. The second Plan is to concentrate on learning how to make the best use of the equipment thus secured, as well as on further building. Immense quantities of new materials will be required, of which home industry is expected to supply at least a part. But in spite of the great advances made by Russia's engineering, metallurgical and chemical industries during the first Five Year Plan, it is very evident that they are not yet in a position to meet all the demands for equipment that must be satisfied if transport is not to remain a " bottle-neck " during the second Plan as during the first. Even allowing for Russia's expressed determination to become self-sufficient ultimately in producing industrial necessities for her transport system, it is obvious that for years ahead she *must* import some of her requirements, notably electrical equipment of every description, parts for locomotives, ships and aeroplanes. *This presents a rich field for British enterprise, of which it is to be hoped that our manufacturers will take advantage before they are forestalled by American and German competitors. The recent electrification of the Moscow suburban railways was carried out partly with British aid, and there is no reason why this should not be followed by further co-operation to the mutual advantage of the two countries concerned.*

The First Chinese Built Motor Vehicles

(*Continued from page 374*)

In the above cost of the Min Sheng truck all labor, overhead, advertising, factory profit, etc., are converted into American dollars at the rate: U.S.$1.00 equals Mex. $2.60 (the same rate of exchange obtaining when the imported trucks were ordered). The costs, therefore, are on exactly the same monetary basis.

From this it is evident that a saving of U.S.$687.41 per vehicle was effected, the major portion of which was represented by labor, overhead, transportation and duty on imported material. With increased production and efficiency, it most certainly would have been altogether practicable to have continued with the venture. But, unfortunately for the undertaking, the seizure of the Liao Ning Trench Mortar Arsenal by the Japanese put a very definite end to the manufacture of motor trucks by the Chinese organization. However, it did not bring an end to the ambitions of the numerous young Chinese engineers who had the opportunity to assist in the designing of the vehicles. These men, although scattered to various parts of China, are now awaiting the time when they can participate in a similar project. It is as much with these men in mind as from the actual fact that satisfactory trucks were constructed, that I refer to the Mukden venture as a " successful attempt " to build trucks. It was successful in that it proved that China has, from the standpoint of men as well as means, great possibilities in the building of motor vehicles.

How Land is Won from the River at Shanghai

(*Continued from page 372*)

mixture through a floating pipe line to a shore pipe line, which carries it over dykes. Unfortunately it rarely happens in Shanghai that the dredging and reclamation points are sufficiently near together to allow this process to be used. Furthermore, in navigable channels the floating pipe forms an obstruction to navigation unless the reclamation is on the same side of the channel as the dredging point. The cost of reclamation *per se* is in this case practically the same as with the barge unloading process, but transportation and dredging costs are greatly reduced.

In those places where silt-bearing streams may be narrowed without disturbing the regimen of the river, partial reclamation can be effected by " warping." This has been done by the Board in many places where the Whangpoo was too wide. Cribs of mattresses and stone are laid on the river-bed in such a manner as to check the flow of the water, and if the cribs are sufficiently close together, the spaces between them silt up to above neap high tide level. The speed of silting depends on the position in relation to the river, but, speaking generally, between Shanghai and Woosung such warping proceeds at a rate of from two to four feet depth of mud per annum until half-tide level is reached, and above that level the speed falls to one foot or less per annum, and is only an inch or two per annum in the neighbourhood of the neap high-water level. If this crib work is done on the cancave shores, the silting is slower and, due to eddying hollows, tend to form at the sides of the outer ends of the cribs. Such warped land, apart from growing reeds, is of little value for agriculture unless it is poldered, and for urban use must be filled artificially.

The Use of Nickel Alloy Steels in the Automotive Industry

(*Continued from page 366*)

Spring clips	S.A.E. 2335
Transmission countershaft	S.A.E. 2315
Rear axle drive gear and pinion	S.A.E. 2315
Rear axle differential gears	S.A.E. 2315
Connecting rod bolts	S.A.E. 2330
Piston pins	S.A.E. 2315
Highly stressed bolts and studs	S.A.E. 2330
Inlet valves	S.A.E. 3140
Piston struts	32 per cent nickel

Motor Cycles and Three Wheelers

In motorcycles, and particularly in three-wheelers, which are very popular in Japan, the three most important qualities are speed, power and ruggedness. The shocks transmitted are especially violent on account of their light weight and use of high grade materials of construction, and the specification of alloy steels and their heat treatments are therefore essential.

For crankshafts, drive shafts, and main transmission shafts, S.A.E. 3115 nickel-chromium steel is employed, heat-treated as follows: Carburize at 885° to 910°C to a case depth of 0.8 mm.: cool in box, heat to 830° to 855°C, quench in oil, reheat to 745° to 775°C, quench in oil. A tempering operation follows at 120° to 230°C, depending on the final hardness desired, which is Rockwell (C) 58 to 60 for the transmission shafts, and 60 to 63 for the other parts above-mentioned.

For piston pins, the same steel is used and the same depth of case is specified, but the pins are quenched direct into oil from the carburizing boxes, reheated to 760° to 785°C, again quenched into oil, and tempered to give a hardness of Rockwell (C) 60 to 63.

S.A.E. 2315, 3.5 per cent nickel which are carburized at 870° to 900°C, cooled in the box, heated to 815° to 840°C, quenched into oil, reheated to 735° to 760°C, quenched into oil and drawn to Rockwell (C) 58 to 60.

The connecting rods are specified in S.A.E. 3140 nickel-chromium steel, and are heat treated by quenching in oil from 800° to 830°C and tempered to 40 to 45 Rockwell (C).

Miscellaneous screws and bolts subject to high stress are made of S.A.E. 2330 nickel steel, oil quenched from 785° to 815°C and tempered to a Rockwell (C) hardness of 30 to 33.

Shanghai Dry Dock Nears Completion

PLANS for the construction of a 600-foot dry dock, the biggest in Shanghai, will be partly realized in September when the No. 3 Dock, 375 feet long, 89 feet wide and 26 feet deep, with ample space for expansion to its planned capacity, will be formally opened at the Naval Ministry's Kiangnan Dock, Kiaochangmiao.

The authorities are planning to complete the entire construction programme with the least possible delay. It is expected that following the completion of the first stage of the programme, work on the expansion will be carried out immediately. When completed, the dock will be 600 feet long, 100 feet wide, and 26 feet deep. The cost of the first stage of the work is estimated at $1,200,000.

The construction of the dock, which is capable of accommodating steamers of over 10,000 tons, fills a long-felt need in marine activities in this port in view of its increase in shipping and now regular visits of large liners. To Kiangnan Dock, the construction is the more imperative in view of the increase in business.

Plans for the construction of the new dock were drawn up more than two years ago after protracted negotiations with the Ministry of War for a large piece of land of the Kiaochangmiao Arsenal, which is adjacent to the Kiangnan Dock for the new dock. These were, however, held up by the Sino-Japanese hostilities in Shanghai.

Because of the financial stringency caused by the fighting, the authorities found it necessary to change the original plans. It was then decided that the work should be divided into two stages, so that a comparatively smaller dock may first be constructed to cope with the demand for another dock. A contract was then signed with Messrs. L. W. Painter Co. in May last year, and work was immediately started.

Established 69 years ago, the Kiangnan Dock was originally attached to the Kiangnan Arsenal but was later divided into two separate organizations. Since the inauguration of the National Government, the Kiangnan Dock was put under the direct control of the Ministry of Navy.

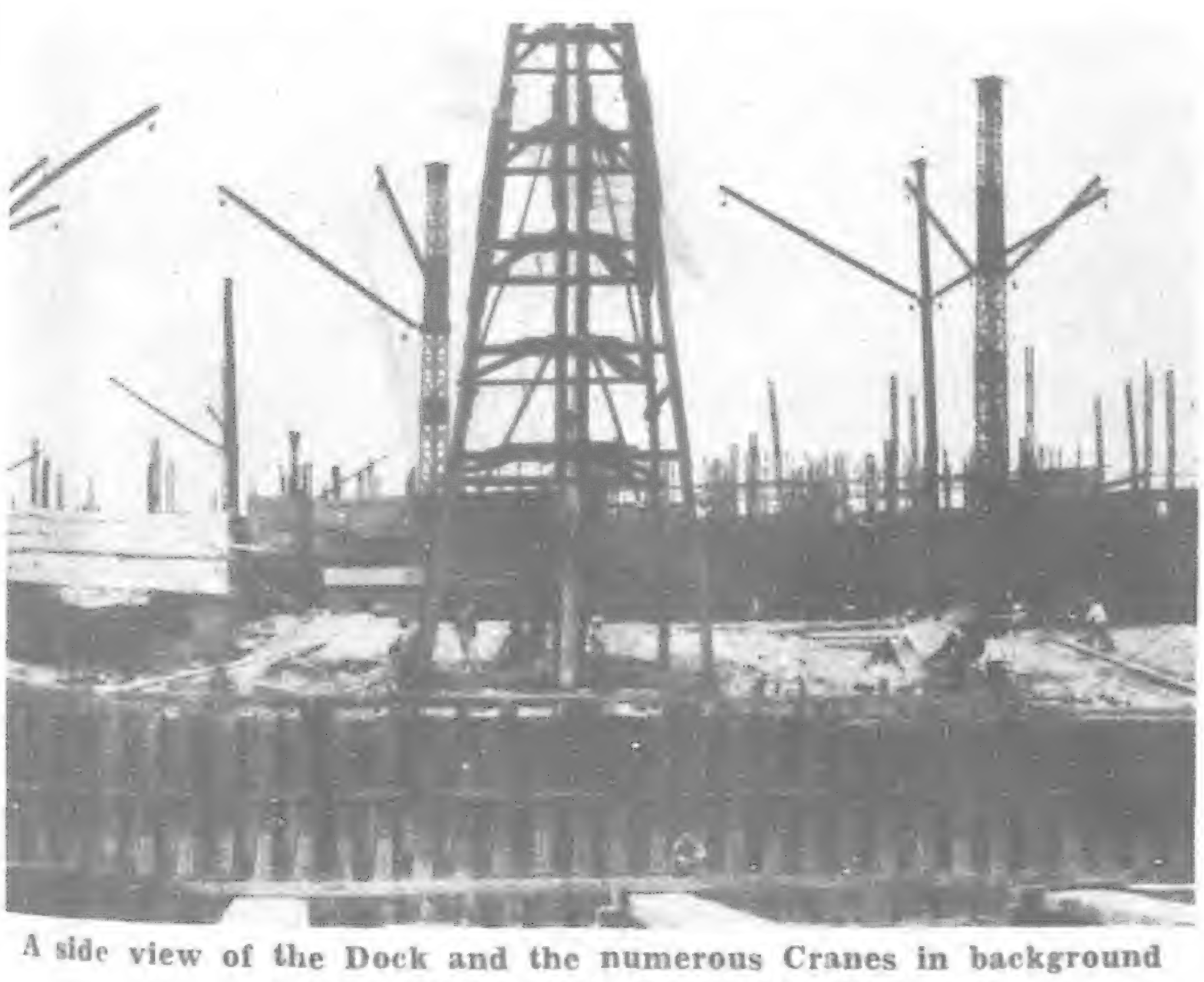
The No. 1 Dock was constructed 67 years ago. It was originally mud-bottomed, and 325 feet long. Many years after its construction, it improved and extended to 375 feet. As steamers over 4,000 tons could not be docked there, the dock was further expanded, to its present capacity: 545 feet long, 66 feet wide, and 20 feet deep.

In 1925, a second dock was opened in the winter. Equipped with modern machinery, the second dock is 502 feet long, 61 feet wide, and 23 feet deep.

In view of the lack of a dock big enough to accommodate vessels of over 10,000 tons, and the increase in orders for docking, plans for the third dock were discussed. It is hoped by the authorities that its completion will not be far distant.

River End of the 600-foot Dock constructed at Naval Ministry's Kiangnan Dock, Kiaochangmiao. A section of the Huge Lock is seen on right being completed Inside Dock

The Land End of the new Dock which is to be extended from 375 feet to 600 feet to accommodate vessels of over 10,000 tons. Buildings in background are to be demolished



A side view of the Dock and the numerous Cranes in background where vessels are being constructed

One corner of the new Dock which is 26 feet deep.

Customs Cruisers Built at Shanghai

The *Hai Sui*, *Hai Ching* and *Hai Ho* are three of a number of similar craft which have recently been built by the New Engineering and Shipbuilding Works, Ltd., to the order of the Chinese Maritime Customs, for service in the Preventive Branch, being specially equipped for this duty.

They are of the combined Bridge and forecastle type and their main dimensions are: Length overall, 137-ft. 6-in., Length, B.P. 130-ft., moulded Breadth, 25-ft., moulded Depth, 11-ft., Loaded Draught, 8-ft. 2-in. They are built of steel to Lloyds Rules, and are subdivided into seven watertight compartments by six watertight bulkheads extending to the main deck.

The vessels have a raked stem and cruiser stern, and have a smart appearance. They have been built with two steel decks, sheathed with teak where exposed.

On the bridge deck, the wheelhouse, captain's cabin, and wireless room are located in one house, which is constructed of bullet-proof steel with doors and windows of the same material. A watertight ammunition magazine and hoist are located forward with ammunition and shelves to supply the three pounder gun which is mounted on the forecastle head, behind a permanent bullet-proof protection.

The officers accommodation is situated on the main deck forward and includes a spacious and comfortable wardroom. The petty officers are located on the main deck aft and there is accomodation below this deck for 22 of the crew.

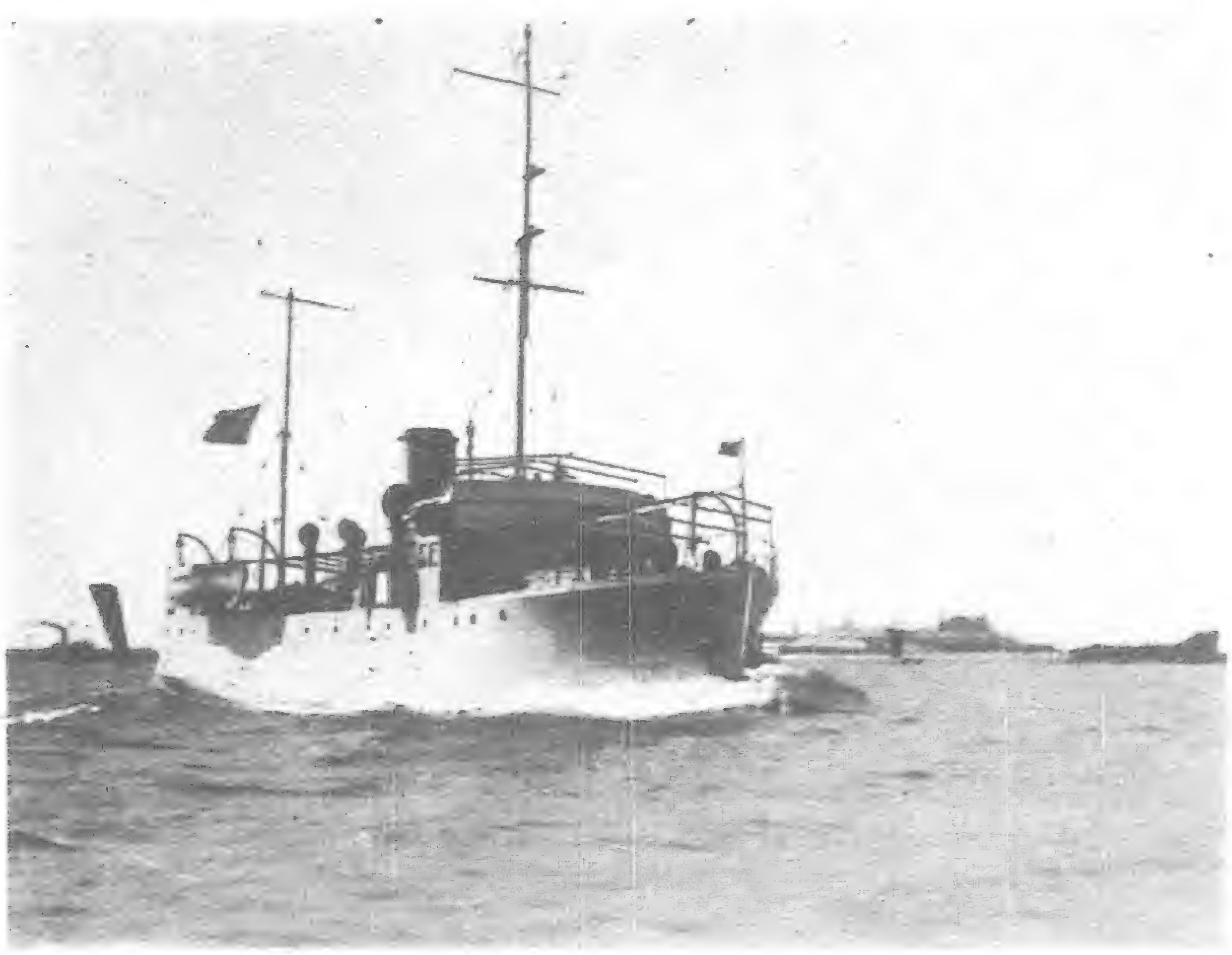
The refrigerating equipment and stewards stores and offices are also arranged forward under the main deck.

A powerful combined steam windlass and capstan of naval pattern is installed on the forecastle head for the efficient handling of the anchors and a steam capstan is fitted on the boat deck aft with suitable leads for warping and handling the ship's cutter and gig. The vessels are also fitted with steam steering gear.

The propelling machinery for these vessels has been specially designed and constructed by the builders at their Yangtszepoo Yard, and consists of two sets of three crank Triple Expansion Surface Condensing Engines developing ample power to give the vessels a speed of over 12 knots, and operating under steam supplied by two single-ended three furnace, cylindrical Scotch boilers, also designed and constructed by the builders, burning coal under the well known "Howden" system of forced draught, and operating at a pressure of 190 lbs. per sq. inch. The auxiliary machinery is of the best modern type, all independent of the propelling machinery, and includes a surface condenser of the "Uniflux" type, of mild steel, common to both engines, one Weirs Air Pump, one centrifugal circulating pump, two Weirs main feed pumps, and one Weirs feed heater. An ash-ejector pump and a bilge and general service pump are also fitted.

The vessels are lighted throughout by electricity current being supplied by duplicate sets of Diesel-engine driven generators. Two searchlights and a Marconi wireless installation also form part of the equipment.

These vessels were built and equipped to suit their own special service and their construction has been supervised by the Coast Inspector's Department together with the Departments Marine Surveyors.




Views of two of the new Customs Cruisers built by the New Engineering & Shipbuilding Works, Ltd.

Steel Making Processes with Particular Reference to the Production of Steel Castings

(Continued from page 347)

From the steelmaker's point of view the operation of making steel begins with the charging of the furnace, includes the melting and refining of the charges, and concludes with the tapping of the molten steel into the ladle. After this point, technically speaking, the steelmaker's responsibility ends, his tapping samples, which should always be carefully preserved, proving the soundness of the steel and its correctness as regards composition. Unfortunately good sound steel in the ladle does not necessarily mean good sound castings, as there are numerous ways in which the steel can be spoilt after leaving the ladle. It is a very serious fallacy to imagine that once the steel is cast into the moulds the job is more or less finished; as a matter of fact it has only reached about the half-way stage. As previously mentioned, unless the correct sands have been used for making the moulds, thus ensuring sufficient porosity combined with non-fusibility (to withstand the high temperatures involved) the castings will contain blowholes. Inadequate drying of the moulds, which should be stoved overnight, will also cause "blowy" castings. Hot tears and sometimes cracks will readily occur in castings of intricate shape if they are not quickly released from the moulds. All steel Castings should have some sort of heat treatment. This usually takes the form of a simple annealing, which should take place as soon after casting as possible. This heat treatment should be done in a muffle-type furnace to avoid scaling, the correct time and temperature depending upon the size and analysis of the castings.

It will thus be appreciated that the production of good steel castings is no sinecure, and the writer hopes that the foregoing remarks, brief and elementary though they are, may prove of some assistance to prospective steelfounders.

Replacement Shipbuilding in Japan

By *EISABURO KUSANO*

THE Japanese government killed two birds with one stone when the three year project of building 200,000 tons of speedy freighters to replace (by scrapping) 400,000 tons of obsolete tonnage was fully contracted for in April, 1934, or within one year and a half after the enactment of legislation that provided for Y.11,000,000 subsidy. For the measure has not only adjusted the surplus supply of space in Japan's shipping market but it has also contributed substantially to the qualitative improvement of Japan's merchant marine. The direct benefit of this master stroke has been that Japan's shipping and shipbuilding circles have been active irrespective of the world depression, and that disaster at sea in Japan has considerably decreased since 1932, largely because 94 ships, 399,000 tons, classed as obsolete (including 76 vessels, 305,000 tons, all of which are older than 35 years in age) have been eliminated from active service.

The merchant marine qualitative improvement legislation, which has thus accounted for an all-round betterment of Japan's shipping and shipbuilding, has been so successful and popular that an active movement is at present going on for the continuation of a similar enterprise by the government as a new five year program. The Japan Shipowners' Association, the Shipbuilders' Association, and the Ships Improvement Association have made a joint proposal to the communications authorities to renew the legislation as follows:

(1). The merchant marine qualitative improvement enterprise by the government should be continued for five consecutive years.

(2). Under the new legislation, 500,000 tons of new ships should be constructed and an equal tonnage of obsolete ships should be scrapped.

(3). The government subsidy should be granted at the rate of Y.50 per ton to the maximum total of Y.25,000,000.

Meanwhile the communications authorities, at their departmental conference held early in May, 1934, decided to continue the enterprise in principle, in view of the fact that there are still 560,000 gross tons of old ships that need to be scrapped, as was pointed out by Communications Minister Hiroshi Minami at the last session of the Diet, convened early in 1934. They are expected, moreover, to open negotiations with the finance authorities as regards the appropriation of the subsidy in question, although it remains to be seen how the ratio between the tonnage of new ships to be built and that of obsolete ships to be scrapped will be fixed, and what will be the per ton subsidy as well as the maximum total thereof. These are to be decided by the marine affairs commission of the Communications Department, which was scheduled to meet about the middle of June, 1934. It will be some time during the summer of 1934, when the 1935-36 budget estimates are to be worked out, that tangible negotiations will take place between the communications and the finance authorities.

In the meantime, a résumé of how the first merchant marine qualitative improvement subsidy legislation was put into effect and how the legislation was used by Japanese shipowners, will be given:

Review of Events

Following the suspension of the gold standard in December, 1931, Japan's shipping circles were temporarily animated as the result of the yen exchange rate depreciation and also due to the advance in domestic commodity prices. From the spring to the summer of 1932, however, under the pressure of accumulation of such adverse factors as the political uncertainty, general unrest, the aggravation of international relationships, and trade inactivity, the shipping space supply much exceeded demand both in the near-seas and ocean-going markets. Freightage tumbled below costs, and shipping companies were unanimously hard hit. Then the shipbuilding industry was also severely affected. Indications were that the crisis was so acute that many dockyards might pass out of existence altogether unless something was done immediately to relieve them.

It was in the face of such a pressing situation that the government decided to relieve the shipping and shipbuilding industries. It organized the Marine Affairs Commission in July, 1932, and, on the recommendation of this commission, the bill advocating the qualitative improvement of the Japanese merchant marine by constructing new ships to replace obsolete tonnage and simultaneously to give work to the dockyards was introduced in the extraordinary session of the Diet convened in August, 1932. The bill was then passed on conditions which, in substance, were as follows:

(1). The government should subsidize the construction of ships to the extent of 200,000 gross tons, provided that these will be built at dockyards within the Main Island, and that obsolete tonnage will be scrapped simultaneously. And the government should contract within three years beginning the fiscal year 1932-33 for delivery of the said subsidy within the following limitations:—(Unit: Y.1,000).

Years	*Subsidy*
1932-33	1,250
1933-34	5,500
1934-35	4,250
Total	11,000

(2). The foregoing subsidy shall be granted on the following conditions:

(*a*) The ships to be scrapped are required to be steamers older than 25 years in age and not smaller than 1,000 tons in gross tonnage, unless the Communications Minister approves the adjustment of terms in individual cases.

(*b*) The ships to be constructed in replacement are required to be steel boats of not smaller than 4,000 tons, and their total tonnage must be larger than one-third of that which is to be scrapped.

(*c*) The shipowners expecting to receive the subsidy on their respective projects of replacement construction must first obtain the Communications Minister's approval thereof.

(*d*) When the aggregate total tonnage of replacement construction exceeds one-half of the total tonnage to be scrapped, the subsidy is not to be granted on the surplus construction tonnage.

(*e*) In case of failure to adhere to the regulations governing the present replacement construction program, the contract is to be cancelled, the subsidy payment to be stopped, the already paid subsidy to be returned to the government, and moreover, the government may levy penalty when such is deemed appropriate.

In accordance with the foregoing terms set forth by the Diet, the Communications Department, on September 27, 1932, promulgated a departmental decree, giving the details of how the government subsidy was to be granted on the construction of new ships under the qualitative improvement legislation. In part, the decree was more specific than the conditions on which the Diet passed the bill. Main points of difference were:

(1). The ships to be scrapped are required to be either steel or iron steamers, older than 25 years in age and not smaller than 1,000 tons in gross tonnage, which were registered in the Main Island, Chosen, Taiwan, and the Japanese leased territory of Kuantung previous to (and including) January 1, 1932. When approved by the Communications Minister, however, the ship's age may be under 25 years.

(2). The ships to be constructed in replacement of obsolete tonnage are required to be steel freighters not smaller than 4,000 tons, equipped with engines capable of developing more than 13½ knots. When approved by the Communications Minister, however, the speed may be less than 13½ knots.

(3). When replacement building and scrapping are contemplated on more than two ships at the same time, the ratio between the two categories of ships may be considered collectively on the basis of their respective combined total tonnages.

Conditions Set Forth

In addition to these terms of subsidy, the actual amount of subsidy thus to be granted was adjusted by degrees in accordance with the speed of these individual ships as follows :—(Unit : yen).

Speed	*Subsidy per ton*
Less than 14 knots	45
More than 14 ,,	46
,, ,, 14½ ,,	47
,, ,, 15 ,,	48
,, ,, 15½ ,,	49
,, ,, 16 ,,	50
,, ,, 16½ ,,	51
,, ,, 17 ,,	52
,, ,, 17½ ,,	53
,, ,, 18 ,,	54

Side by side with the enactment of this merchant marine qualitative improvement legislation, and the promulgation by the Communications Department of its departmental decree, the Merchant Marine Improvement Association, a corporate judicial entity, was promoted under the joint auspices of the shipowners and shipbuilders who are respectively members of the Japan Shipowners' Association and the Japan Shipbuilders' Association, with Teijiro Kawamura, of the Mitsuis, as chairman of the board of directors, for the purpose of facilitating the smooth operation of the legislation in question. And the actual work of this Association has been conducted through its committee called the Kanri Iinkai.

The committee has met in conference on a number of occasions but at its first and the most important session decided on the regulations governing its function, in effect, as follows :

(1). Adjustment of demand and supply of old ships to be scrapped in connection with the replacement building, and exertion of good offices between the shipowners and dockyards.

(2). Drafting of programs for execution by the government as regards the actual grant of the subsidy.

(3). Decision of order in the construction of new ships and scrapping of old vessels.

(4). Issuance of certificates for shipowners and dockyards testifying their respective contracts of construction of new ships, scrapping of old boats, and so on.

(5). Execution on behalf of the shipowners upon their respective requests of such official affairs as the application to the government for the subsidy and the receiving thereof.

(6). Distribution of the subsidy between owners of the ships to be built and to be scrapped.

(7). To superintend the actual replacement construction so that the terms on which the government subsidy is given are fully observed to the letter.

(8). Collective bargain with the iron foundries, ship-scrappers, and others.

(9). Prevention of import into Japan of old foreign ships.

(10). Adjustment of the cost construction and the market quotation of the scrap ships.

(11). Exertion of good offices in obtaining accommodations to finance the ship construction projects.

(12). Investigation into the qualifications of the ships to be scrapped.

(13). Other duties necessary for the smooth progress of the enterprises of this committee.

The merchant marine qualitative improvement legislation was thus put into effect on October 1, 1932, as a three year program ending at the close of the fiscal year 1934-35 or on March 31, 1935. This legislation, side by side with the remarkable recovery of shipping caused shipowners to become enthusiastic about the construction of new freighters, taking advantage of the government subsidy. As a matter of fact, their construction plans filled up the subsidy schedule in March, 1934, or exactly one year previous to the official closing.

For in March, 1934, there were 29 ships, 190,110 gross tons for the construction of which the subsidy was either already paid or decided to be paid. That is, their construction under the present replacement construction legislation was "approved" by the government. In addition, there were two ships, 9,200 gross tons, for which application for approval was filed with the government. (The applications for these ships were O.K.ed in April.) The total tonnage of these "approved" and "applied" ships, numbering 31, amounted to 199,310 tons, which is short of the original project of building 200,000 tons only by 690 tons. Meanwhile the ships already scrapped, being scrapped, and decided to be scrapped numbered 94 vessels, 399,122 gross tons, and the government subsidy already paid or earmarked to be paid amounted to Y.9,947,400 while the sum for which the applications were filed amounted to Y.441,600, the total amounting to Y.10,389,000, which was short of the original project of Y.11,000,000 by Y.611,000. See the accompanying table :

REPLACEMENT CONSTRUCTION

(March, 1934)

	No. of ships	*Tonnage (gross)*	*Subsidy (yen)*
Approved	29	190,110	9,947,400
Applied	2	9,200	441,600
Totals	31	199,310	10,389,000
Margin available	..	690	611,000

REPLACEMENT SCRAPPING

(March, 1934)

	No. of ships	*Tonnage (gross)*
Decided	89	380,794
Projected	5	18,328
Totals	94	399,122

Note :—In the replacement scrapping, the ships already torn up as well as those under scrapping are included in the item termed "decided."

As one may easily surmise, to build 199,210 gross tons of new ships under the replacement legislation, the tonnage of obsolete ships that is required to be scrapped is 398,620 tons. Consequently, the foregoing total of the "scrap" ships amounting to 399,122 gross is in excess of the actual necessity by 502 tons. Nevertheless, as the replacement construction is closed by filling up the schedule, this excess of scrap tonnage is a net surplus, without having any program to accommodate.

Preliminary particulars of the 31 vessels, 199,310 tons, which are built, being built, and proposed to be built, with the government subsidy amounting to Y.10,389,000, under the merchant marine qualitative improvement legislation, compiled by Kazundo Ogata, of the *Osaka Mainichi* primarily for the *Far Eastern Review*, runs as follows :

Replacement builder, ships, ship's name	*Designated tonnage (gross)*	*Designated speed (knots)*	*Keel laid*	*Date of completion*	*Subsidy (per ton)*	*Total subsidy (yen)*	*Dockyard*
Nippon Yusen Kaisha :—							
No. 1 : (undecided)	7,300	18	Mar. 1933	July 1934	54	394,200	Yokohama
No. 2 : ,,	7,300	,,	Sept. ,,	Sept. ,,	,,	,,	Uraga
No. 3 : ,,	7,300	,,	Oct. ,,	Sept. ,,	,,	,,	Nagasaki (Mitsubishi)
No. 4 : ,,	7,300	,,	Dec. ,,	Nov. ,,	,,	,,	,,
No. 5 : ,,	7,300	,,	Oct. ,,	Dec. ,,	,,	,,	Yokohama
No. 6 : ,,	7,300	,,	Feb. 1934	Jan. 1935	,,	,,	Nagasaki (Mitsubishi)
Mitsui Bussan Kaisha :—							
No. 1 : *Azumasan Maru*	7,600	18.5	Nov. 1932	July 1933	54	410,400	Tama (Mitsui)
No. 2 : *Amagisan Maru*	,,	,,	Dec. ,,	Dec. ,,	,,	,,	,,
No. 3 : (undecided)	6,500	,,	Mar. 1933	Dec. 1934	,,	351,000	,,
No. 4 : ,,	,,	,,	,, ,,	Mar. 1935	,,	,,	,,
No. 5 : ,,	4,600	15	—	,, ,,	48	220,800	,,
No. 6 : ,,	,,	,,	—	,, ,,	,,	,,	,,

Replacement builder, ship's name	Designated tonnage (gross)	Designated speed (knots)	Keel laid	Date of Competion	Subsidy (per ton)	Total subsidy (yen)	Dockyard
Toyo Kisen (T.K.K.) :—							
No. 1 : *Uyo Maru*	7,450	16	Nov. 1932	Sept. 1933	50	372,500	Nagasaki (Mitsubishi)
No. 2 : *Nichiyo Maru*	,,	,,	Jan. 1933	Apr. 1934	,,	,,	,,
No. 3 : *Getsuyo Maru*	,,	,,	Mar. ,,	June ,,	,,	,,	,,
No. 4 : (undecided)	6,850	,,	July 1934	Feb. 1935	,,	342,500	,,
Kokusai Kisen :—							
No. 1 : *Shikano Maru*	6,900	18.75	Dec. 1932	May 1934	54	372,600	Uraga
No. 2 : *Seicho Maru*	7,000	18.5	May 1933	Oct. ,,	,,	378,000	Kawasaki
No. 3 : *Kongo Maru*	,,	,,	Feb. 1934	Feb. 1935	,,	,,	Harima
Iino Shoji :—							
No. 1 : *Toa Maru*	9,865	18.5	Apr. 1933	May 1934	54	532,710	Kawasaki
No. 2 : *Kyokuto Maru*	10,010	,,	Nov ,,	Dec. ,,	,,	540,540	,,
Osaka Shosen (O.S.K.) :—							
No. 1 : (undecided)	4,400	16	Sept. 1934	Mar. 1935	50	220,000	Nagasaki (Mitsubishi)
No. 2 : ,, ...	,,	,,	,,	,,	,,	,,	,,
No. 3 : ,, ...	,,	,,	,,	,,	,,	,,	,,
Kinkai Yusen :—							
No. 1 : (undecided)	4,400	16	Sept. 1934	Mar. 1935	50	220,000	Yokohama
No. 2 : ,, ...	,,	,,	,,	,,	,,	,,	,,
Takachiho Shosen :— *Takaei Maru*	6,800	16	Feb. 1933	Jan. 1934	50	340,000	Nagasaki
Shinko Shosen :— (undecided)	6,400	16	July 1934	Mar. 1935	50	320,000	Yokohama
Shimaya Kisen :— (undecided)	4,600	15	Mar. 1934	Dec. 1934	48	220,800	Tama (Mitsui)
Azuma Kisen :— *Shinshu Maru*	4,185	16	Apr. 1933	Jan. 1934	50	209,250	Kobe (Mitsubishi)
Yamamoto Kisen :— (undecided)	4,150	16	Aug. 1934	Mar. 1935	50	207,500	Kobe (Mitsubishi)

Note :—The builders are : Nagasaki and Kobe works of the Mitsubishi Heavy Industrial Co., Ltd. ; Tama works, of the Mitsui Shipbuilding Yard ; Yokohama Dockyard Co., Ltd. ; Uraga Dockyard Co., Ltd. ; Kawasaki Dockyard Co., Ltd. ; Harima Shipbuilding Yard, Ltd.

An analysis of the table of preliminary particulars reveals that there are 12 shipping companies that availed themselves of the merchant marine qualitative improvement legislation. Of these, the N.Y.K. heads the list both in the number and tonnage of ships it is building as well as in the amount of subsidy that it has and is to receive. When the two ships that its sister company, the Kinkai Yusen, proposes to build are added, the total amounts to eight vessels, 52,600 gross tons, which corresponds to one-fourth of the aggregate total of the replacement construction. Next comes the Mitsui Bussan, followed by the Toyo Kisen, the Kokusai Kisen, and so on, as is shown in the accompanying table :

Replacement builders	*No. of ships*	*Tonnage (gross)*	*Subsidy (yen)*
N.Y.K.	6	43,800	2,365,200
Mitsui Bussan	6	37,400	1,964,400
Toyo Kisen	4	29,200	1,460,000
Kokusai Kisen	3	20,900	1,128,600
Iino Shoji	2	19,875	1,073,250
O.S.K.	3	13,200	660,000
Kinkai Yusen	2	8,800	440,000
Takachiho Shosen	1	6,800	340,000
Shinko Shosen	1	6,400	320,000
Shimaya Kisen	1	4,600	220,800
Azuma Kisen	1	4,185	209,250
Yamamoto Kisen	1	4,150	207,500

In view of the fact that the replacement construction under the present legislation must satisfy conditions in tonnage and speed (not smaller than 4,000 tons ; not lower than 13 knots), all the ships that are now under construction and proposed to be built are larger than 4,000 tons and their respective speed is higher than 15 knots. Furthermore, there is one of which the speed is 18.75 (Kokusai Kisen's *Shikano Maru*, 6,900 tons), which is exceptionally high as a freighter in Japan.

Another noteworthy fact is that 26 out of these 31 ships are or to be equipped with Diesel engines ; the remainder of five ships (the O.S.K. and Kinkai Yusen boats) are to have turbine engines. It tends to prove the advantage of the Diesel engines in the case of ocean going liners because of their easy access to the oil supply.

A classification according to the size of these vessels finds that there are only 10 ships, 44,135 gross tons, or 22.1 per cent of the total, which belong to the 4,000 ton class, the smallest type, in the present building program and that all the rest are larger than 6,000 tons. Of these, the 7,000 ton type is the largest in number and tonnage, almost one half of the total (13 vessels, 95,350 tons).

As regards the speed, 15 knots happens to be the lowest, and the number and tonnage of ships of this class are not so large, while the ships having more than 18 knots of speed (for which the largest per ton subsidy of Y.54 is granted) constitute 56.6 per cent of the total, as is seen in the accompanying tables :

(A). Classification by Types :

Types (gross tons)	*No. of ships*	*Total tonnage*	*Percentage against total*
Larger than			
4,000	10	44,135	22.1 per cent
5,000	—	—	—
6,000	6	39,950	20.0 ,,
7,000	13	95,350	47.8 ,,
8,000	—	—	—
9,000	1	9,865	4.9 ,,
10,000	1	10,010	5.0 ,,
Totals	31	199,310	100

(B). Classification by Speed :

Designated speed	*No. of ships*	*Total tonnage gross*	*Percentage against total*
More than			
15.0 knots	3	13,800	6.9 per cent
15.5 ,, ...	—	—	—
16.0 ,, ...	13	72,735	36.5 ,,
16.5 ,, ...	—	—	—
17.0 ,, ...	—	—	—
17.5 ,, ...	—	—	—
18.0 ,, ...	6	43,800	21.9 ,,
18.5 ,, ...	8	62,075	31.2 ,,
18.75 ,, ...	1	6,900	3.5 ,,
Totals	31	199,310	100

A comparative study of these two tables of classification according to the types and speed reveals the fact that the freighters built, being built, and proposed to be built under the replacement construction legislation are mostly large ships with high speed.

As regards the dockyards building these new ships under the replacement construction program, the Mitsubishi heads the list with its Nagasaki and Kobe works obtaining the contract for 13 vessels, 79,435 tons, or more than 40 per cent of the total. Details follow:

(C). CLASSIFICATION BY DOCKYARDS:

Contracts given by	Type of ships (tonnage)	Number
(1). Mitsubishi, Nagasaki works, 11 ships, 71,100 tons:		
N.Y.K.	7,300	3
Toyo Kisen	7,450	3
Toyo Kisen	6,850	1
O.S.K.	4,400	3
Takachiho Shosen	6,800	1
(2). Mitsubishi, Kobe works, 2 ships, 8,335 tons:		
Azuma Kisen	4,185	1
Yamamoto Kisen	4,150	1
(3). Mitsui, Tama works, 7 ships, 42,000 tons:		
Mitsui Bussan	7,600	2
,, ,,	6,500	2
,, ,,	4,600	2
Shimaya Kisen	4,600	1
(4). Yokohama Dockyard, 5 ships, 29,800 tons:		
N.Y.K.	7,300	2
Shinko Shosen	6,400	1
Kinkai Yusen	4,400	2
(5). Kawasaki Dockyard, 3 ships, 26,875 tons:		
Kokusai Kisen	7,000	1
Iino Shoji	9,865	1
Iino Shoji	10,010	1
(6). Uraga Dockyard, 2 ships, 14,200 tons:		
N.Y.K.	7,300	1
Kokusai Kisen	6,900	1
(7). Hariyma Shipbuilding, 1 ship, 7,000 tons:		
Kokusai Kisen	7,000	1

The foregoing list is a convincing proof of how the replacement construction plan has benefitted Japan's shipbuilding circles.

Of the total of 31 vessels, 199,310 tons, there were nine ships, 65,300 tons, which were completed before the end of June, 1934, as follows:

Builder	Name	Tonnage	Designated speed (knots)	Dockyard
Mitsui Bussan	*Azumasan Maru*	7,600	18.5	Tama
,, ,,	*Amagisan* ,,	,,	,,	,,
Toyo Kisen	*Uyo* ,,	7,450	16	Nagasaki
,, ,,	*Nichiyo* ,,	,,	,,	,,
,, ,,	*Getsuyo* ,,	,,	,,	,,
Kokusai Kisen	*Shikano* ,,	6,900	18.75	Uraga
Iino Shoji	*Toa* ,,	9,865	18.5	Kawasaki
TakachihoShosen	*Takaei* ,,	6,800	16	Nagasaki
Azuma Kisen	*Shinshu* ,,	4,185	16	Kobe
Totals	9	65,300		

Replacement Scrapping

To build 200,000 tons of freighters under the merchant marine qualitative improvement legislation, the owner-builder must scrap twice as much or 400,000 tons of obsolete ships. So in the actual construction and scrapping under the present replacement program, more than two old ships were scrapped to fulfil the terms of building the new freighters with the government subsidy.

For instance: the N.Y.K. scrapped the *Iyo Maru*, the *Kamakura Maru*, and the *Kawachi Maru* to build its first ship. The combined total of these three old ships amounted to 17,603 tons, while the actual obsolete tonnage necessary to be scrapped to build the first ship, 7,300 tons, is 14,600 tons. And therefore, the scrapping of these three ships gave rise to a surplus of 3,003 tons. This surplus, however, was transferred to the construction of the second ship. Such adjustment of "scrap" tonnage was done everywhere, between various prospective owner-builders. Even then, the adjustment was not always carried out smoothly, especially among minor builders. As the result, the prospective builders of new ships began competing each other to get hold of old ships offered for scrapping, the competition giving rise to the offer on the part of builders of a premium for the privilege to scrap obsolete ships, ranging from Y.10 to Y.13.75 per ton. Large shipping companies which had their own ships to scrap, therefore, had the advantage in not paying such a premium.

Meanwhile the market price of old ships to be scrapped also advanced on account of the increased demand. These ships were sold for from Y.12 to Y.27. This advance, however, was due also to the improvement of the iron and steel market which resulted from the activity of the military provisions manufacturing industries.

Also the cost of construction of new ships rose; it ranged from Y.130 to Y.150 in 1932 but advanced to more than Y.200 per ton.

The ships already scrapped or decided to be scrapped in the present replacement construction system totaled 94 vessels, 399,122 gross tons. In view of the fact that the new ships built, now being built, and proposed to be built are 31 in number and 199,310 gross tons in tonnage, the actual tonnage of old ships scrapped or proposed to be scrapped is 502 tons in excess of the necessary minimum. It consists of the Mitsui Bussan's 495 tons and the Iino Shoji's seven tons.

Further study of "scrap ships" reveals that 74 ships, 309,601 tons were registered in the Main Island, and 20 vessels, 89,501 tons were registered in the Japanese leased territory of Kuantung.

Of the foregoing total of 94 vessels, 399,122 tons, 74 vessels, 257,156 tons were tramps and 20 ships, 141,966 tons were liners. The liners were 21.3 per cent in number and 35.5 per cent in tonnage against the total, revealing that comparatively large types of ships were included among these. On the other hand, the tramps were 78 per cent of the total in number and 64 per cent in the tonnage, indicating that small type ships were included in this group.

That most of the "scrap ships" were freighters will be seen in the table to follow:

	Number	Tonnage (gross)
"Scrap" Liners:		
Freighters	16	113,595
Passenger boats	4	28,371
"Scrap" Tramps:	*Number*	*Tonnage (gross)*
Freight—Passenger ships	9	15,982
Freighters	54	202,340
Floating factories	10	29,780
Tanker	1	9,122

The following table gives the "scrap ships" according to their respective size: (gross tons).

Size (tons)	Number	Total tonnage	Percentage against total
Under 2,000	8	12,041	3 per cent
2,000—3,000	28	72,698	18 ,,
3,000—4,000	15	53,920	13.5 ,,
4,000—5,000	14	62,036	15.5 ,,
5,000—6,000	17	95,835	24 ,,
6,000—7,000	3	18,102	4.5 ,,
7,000—8,000	5	38,379	9.6 ,,
8,000—9,000	—	—	—
9,000—10,000	1	9,049	2.2 ,,
Above 10,000	3	39,062	9.7 ,,

The foregoing table reveals the fact that the "scrap ships" under 5,000 tons numbered 65 ships, 200,795 tons, or 70 per cent in number and more than 50 per cent in tonnage against the total. In view of the fact that these smaller types of ships were held largely responsible for the deterioration of conditions in the shipping market, one may easily surmise the favorable effects their disappearance has brought forth on the freightage as well as on the charterage.

The last table classifies the "scrap ships" according to their respective age:

Age	Number	Total tonnage	Percentage against total
Under 20 years	4	26,809	6.7 per cent
Above 20 ,,	1	3,402	0.9 ,,
,, 25 ,,	13	64,643	16.2 ,,
,, 30 ,,	21	109,806	27.5 ,,
,, 35 ,,	28	121,029	30.3 ,,
,, 40 ,,	27	73,433	18.4 ,,

It is a significant fact that the ships older than 30 years of age numbered 76 ships, 304,268 tons, their disappearance meaning a substantial improvement of the quality of Japan's merchant marine.

Engineering Notes

INDUSTRIAL

FACTORY TO BE BUILT.—Toyo Spinning Company, Osaka, has announced a plan for staple fibre production. A new factory is to be erected at Osone, a suburb of Nagoya. Operations will begin in June.

NITRIC ACID PLANT FOR CHINA.—The first synthetic nitric acid plant for China is to be established at Chenkiatu, western part of Shanghai, by the Tien Chu Ve-Tsing Manufacturing Co., with a capital of $1,000,000.

PAPER MILL FOR CANTON.—Canton Reconstruction Department has decided to establish a large paper mill in that city. Experts, after investigations, have reported that the Pak Kong and Fat Shan districts are the most suitable places, as they are rich in forests and have numerous waterfalls. Plans submitted to the Canton Government await approval.

CHUNG SHAN UNIVERSITY.—The Canton authorities have decided to push on with the expansion of the Sun Yat-sen (Chung Shan) University, involving a sum of $20,000,000 and the erection of new college buildings at Shekpai, in the outskirts of Canton. An appeal addressed to Nanking requests the Government to remit immediately $2,500,000 and also to appropriate each month $100,000 from the Customs surplus.

CANTON'S NEW ARSENAL.—Canton is steadily increasing its armaments. In addition to the purchase of aeroplanes and submarines, enormous sums are being expended on arsenals. An expansion scheme for the Shekching arsenal is being carried out, and the military have ordered the construction of a new plant at Pakong for the manufacture of arms and ammunition. Work on the construction of the Pakong arsenal is reported to have commenced, while machinery to the value of $16,000,000 has been ordered from Europe. The construction of the plant itself will cost over $5,000,000. There will be factories for the manufacture of heavy guns, machine-guns, rifles, shells, and bombs.

NITRIC ACID PLANT.—A new chemical plant will shortly be built in Shanghai under the auspices of a group of Chinese industrialists who have already played an active rôle in the development of the chemical industry in this country, says *Havas*. The main product of the projected plant will be synthetic nitric acid. The necessary equipment has been ordered in France. The proposed installation will be capable of producing eleven tons of nitric acid daily, using ammonia furnished by another factory belonging to the same group. The plant will also be equipped for the concentration of sulphuric acid. It will be the first of its kind in China and the type of synthetic acid production which is planned is the last word in modern industrial chemistry.

WORK AT SINGAPORE.—Under the extensive programme to follow the taking over by the military of certain areas of Singapore island, an expenditure of several million dollars is contemplated during 1934, the "Straits Times" understands. Changi, Fort Canning and The Gap are the three main areas affected. Many of the contracts have been let. These include four new barracks blocks and quarters for 30 married soldiers and four warrant officers. Tenders will soon be called for two officers' messes and four married officers' quarters. Developments at Pulau Tekong will guard the approach to Singapore from the China Sea. The contract for certain work has been awarded to Gammon (Malaya), Ltd. Nearly $1,000,000 will be spent under the contracts already let, and the fact that these contracts are let on the quantity system and not by lump sum is a source of gratification to responsible contractors.

PAPER MILL AT WENCHOW.—A loan of $40,000,000 secured on the British Boxer Indemnity Refunds is to be issued by the Nanking Ministry of Industries for the Government paper plant at Wenchow, Chekiang. It is estimated that if the plant can produce 35 tons of newsprint a day, it can make a yearly profit of from $1,500,000 to $2,000,000.

FIBRE FACTORY SCHEME.—A fire manufacturing concern capitalized at Y.10,000,000, planned by Kwansai business men, is to be known as the Toho Jinzo Sen-i Kabushiki Kaisha. The company intends to use the "Viscose Method," and plans a daily production of six tons. Plant cost is estimated at Y.420,000 for one-ton equipment for staple fibre and Y.43 per spindle to spin the rayon fibre.

SINO-GERMAN IRON WORKS.—The final draft of an agreement for the establishment of a Sino-German iron and steel works has been forwarded to an interested German financial group, according to the director of the Mining Department of the Nanking Ministry of Industry. The major revisions in the draft agreement are :—

1. The rate of interest has been reduced from seven per cent. to six per cent.

2. The German financial group proposed that redemption of a loan in connection with machinery purchased from Germany should begin from the third year after the opening of the works. This has been changed to the fourth year.

3. The site of the iron and steel works has been definitely fixed at Ma An Shan, in Anhui province. As soon as the agreement is signed the Ministry of Industry will purchase land there at, or about, twenty dollars a *mow*.

The question of the value of machinery is being carefully considered by technical experts attached to the Ministry.

RAILWAYS

NEW RAILWAY EXTENSION.—The China Government has resolved to extend the Lunghai Railway to Karsi, Sinkiang. The extension will traverse Shensi and Kansu, thence into Sinkiang.

UNDERGROUND RAILWAY PROPOSAL.—The Hanshin Electric Railway has been granted a charter for the construction of an underground railway in Kobe at a cost of ten million yen. The track gauge will be 1.435 meters and the length 3 km.

FINANCE FOR RAILWAYS.—To complete the Canton-Hankow Railway the Chinese Government probably will float bonds worth between $16,000,000 and $20,000,000, secured on the Sino-British Boxer funds. The Executive Yuan has adopted regulations governing the issue of Kiangsi-Yushan-Pinhsiang Railway bonds in 1934.

ELECTRIFICATION IN JAPAN.—Further railway electrification to be undertaken by the Japanese Government this year includes lines between Kyoto and Suita (35.2 km.), Funabashi and Chiba (16.7 km.), Ofuna and Hiratsuka (17.3 km.), Uyen and Matsudo (15.7 km.), Osaka and Sakurajima (8.1 km.), Nagaya and Tajima (36.2 km.) and a further 41 km. section from Minato.

SIBERIAN LINE.—The Soviet's program of double tracking the Trans-Siberian Railway, for a length of 7,000 kilometers, having been completed, similar improvements on all branch lines have begun. Japanese are keenly interested in the completion of the Kamulezukaya-Dutziefskaya section of the Trans-Baikal Railway, as it is most important for the transport of Soviet troops toward Dawlia and Holsia, near the Manchoukuo border.

RAILWAYS FOR MANCHURIA.—South Manchuria Railway Co. has contracted to build seven new railway lines for the Government of Manchoukuo. A total of $141,420,000. Manchoukuo currency, has been appropriated. The new lines will extend from Peony River to Chiamussu, Kirin ; Yingyuan to Jehol City, Jehol ; Yehposhou to Chihfeng, Jehol ; Erhchan to Haiho, Heilungkiang ; Changchun to Talai, Heilungkiang ; Talai, Heilungkiang, to Taonan, Fengtien ; and Huiyuan to Solun, Hsingan province.

CANTON-HANKOW RAILWAY.—Progress on the building of the Canton-Hankow railway is reported. The six or eight tunnels on the Canton end have been completed and work begun on those over the Hunan border. The bridge over the Lei River at Hengchow is ready for construction, piles and foundations all completed. The contract for the station at Hengchow has been let. This will become the headquarters of the engineers until the road is completed. It is reported that another 2½ years will see through trains running.

FUNICULAR RAILWAY TO MIHARA.—A plan to open a funicular railway on Mount Mihara, the volcano on Oshima Island, which has become famous in connection with a ceaseless stream of suicides, has been advanced by men affiliated with the Tokyo Bay Steamship Co., which maintains a regular passenger service to Oshima. The promoters announce that a company capitalized at Y.500,000, fully paid up, will be established. Construction costs for a 1.8 kilometer cable car line are estimated at Y.400,000. The line will be laid between the foot of Motomura-yama and Goshinka-jaya.

RAILWAY CONSTRUCTION IN CHINA.—Following completion of the Wuhu-Sungkapu Railway in Anhwei at the end of May, the Kiangnan Railway Corporation, a private organization, is at work on plans for linking Wuhu and Nanking by railway. The Corporation has mapped out gigantic railway construction schemes in Anhwei, Chekiang and Fukien. Besides extending the railway in Anhwei to Anking, capital of the province, by the end of next year, the concern is planning to extend the Hankiang Railway in Chekiang to Foochow and Chaoan,on the Fukien-Kuangtung border, beginning 1937.

JAPAN'S PRIVATE RAILWAYS.—The Tokyo Ministry of Railways has decided to buy four private railway lines during the next fiscal year. The railways are : Akiyama Railway in Akita Prefecture, which runs between Odate, Rikucho and Hawana, 23 miles, with construction cost of Y.2,153,000. Saku Railway in Nagano Prefecture, running between Komoro and Koumi, 19 miles, with construction cost of Y.2,078,000. Shingu Railway in Wakayama Prefecture, which runs between Odate, Rikucho and Hanawa, with construction cost of Y.750,000. Hinokami Railway in Shimane Prefecture, 13 miles, with construction cost of Y.1,3?4,000.

NEW MANCHOUKUO RAILWAY.—At a cost of approximately Y.4,000,000, a strategic railroad, 270 kilometers long, connecting the recently built Changchun-Tumen Railway with Harbin, has been completed in Manchoukuo. This new railroad serves as a link between the Manchoukuo capital and North Korea, and its completion has an important bearing upon railway development in North Manchuria. Vladivostock is destined to lose much of its significance as an outlet port for Manchurian products, and the S.M.R. will now be able to handle goods brought into Harbin, Dairen or Rashin in North Korea through connection with the Lafatun-Harbin Railway. With construction of the Rashin harbor not yet finished, for some time to come, in any event, merchandize must be brought southward to Dairen.

COMMUNICATIONS

AUTOMATIC 'PHONES IN PEIPING.—The dial system of making telephone-calls is being adopted in several cities in China. Peiping Telephone Administration has placed an order for 3,000 automatic telephones costing about $170,000. The administration has about 18,000 subscribers.

CHINA COMMUNICATIONS.—With a view to fostering closer contact among the nine provinces of Kiangsu, Chekiang, Anhwei, Kiangsi, Hunan, Hupeh, Honan, Chihli and Shantung, the Nanking Ministry of Communications is planning the installation of a network of long-distance telephones and has approached the Board of Trustees for the British Boxer Indemnity Refund for a loan to carry out the project. According to plans, Nanking will be the nerve-center of the system. Altogether there will be four main and four branch lines. The trunk routes will be the Nanking-Shanghai-Hangchow, Nanking-Hankow, Nanking-Peking, and Nanking-Chengchow lines.

NEW RAILWAY IN SHANSI.—Construction of the Government railway between Yutze and Taiku, in Central Shansi, is in progress. This railway connects with the Cheng-Tai Line at Yutze, and will give Taiku direct communication with Shihchiachuang and Taiyuan. Just before the Revolution of 1911, a railway line was surveyed over this seventy-li route. The embankment was completed as far as Taiku, three stations were built, and rails were laid for a short distance. The Revolution brought the work to a standstill until last summer, when the old embankment was repaired, but unusually heavy floods made it impossible to finish the bridge over the Hsiao Ho. Workmen are now throwing a temporary wooden bridge across the stream, and at the present rate of progress, it will not be long until trains are crossing.

BRIDGE FOR HANGCHOW.—The Chinese Government is considering the construction of a $5,000,000 bridge across the Chientang river, near Hangchow. Traffic across the Chientang at the moment is handled by only a few ferry-boats, and the need of a bridge, long felt, has increased with the completion of a network of provincial and national highways, of which Hangchow is the center. A Chinese bridge engineer, Professor Mao Yi-shen, of Peiyang University, has submitted a design, based on the original plans of an American engineer. The new bridge, which will connect Chakou, on the north bank, with Chingkiang, on the south bank, will be two kilometers in length and 40-ft. in width. It will have 130 spans, thirty directly over the river, and will be about 20-ft. above the river level. The entire structure will be of steel and reinforced concrete. The lowest estimate for its construction has been placed at $5,000,000, and it will take at least three years to complete.